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Issued March 20, 1956

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OLIVE WARBLER

PEUCEDRAMUS TAENIATUS

Male and female

Painting by Don R. Eckelberry

THE CONDOR

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SUMMER BIRDS OF THE RINCON MOUNTAINS, SAGUARO NATIONAL MONUMENT, ARIZONA

By JOE T. MARSHALL, JR.

The Rincon Mountains, situated within the Saguaro National Monument just east of Tucson, Arizona, richly merit the attention of those eager to see and understand natural environments in the southwest. These mountains harbor numerous species of Mexican birds responsible for the intense interest of several generations of ornithologists in the neighboring mountains of extreme southern Arizona. They support a varied and beautiful woodland at middle altitudes which differs radically from monotonous stretches of pinyon, juniper, and chaparral at the same level farther north. Trees such as the Chihuahua pine, blue oak, Arizona oak, silver-leaf oak, and Arizona madrone, widely distributed in México, are conspicuous in this woodland, which flourishes next to a boreal forest of majestic proportions. Further, the Rincons contain these contrasting floras and their avifaunas within a moderate-sized area. An hour's walk from a central location, such as Manning Camp, takes one into any of several natural environments, each so different that it is like stepping into a new world. Above the lower limit of oaks, there are about 89 square miles of wooded heights in the Rincons, twenty square miles of which are coniferous forest. Woodland and forest are isolated by desert from the Santa Rita Mountains which lie thirty miles directly south, and they are separated by low hills supporting only scattered oaks in gullies from the Santa Catalina Mountains twelve miles to the northwest.

Mica Mountain, which alone is considered here, lies in the northern part of the Rincons and is of mild relief. The summit area, the highest point of which is 8600 feet above sea level, contains rolling hills and broad drainage basins. Its south slope is of gentle descent; a long ridge inclines to the west; the northwest slope is steep; a barren rocky ridge occupies the northeast corner; and the east end of the elevated forest is bounded by a great cliff, beneath which the land slopes to Happy Valley at the east base of the mountain. Vegetation adorns this uncomplicated topography with a simplicity unique in southeastern Arizona; and contrasting vegetation types meet at the angles of the mountain with rather abrupt transitions. On either side of such a boundary one can determine from the different numbers of a given bird species what it must be choosing for its habitat. Accordingly my purpose, in addition to reporting on variation in House Wrens (a study which first took me to the Rincons), is to represent the relation of breeding birds to vegetation (fig. 1) and to mention unique features of plant and bird life in that portion of the mountain above the desert foothills. The report is based on my notebook entries made on visits on January 20 and 21, 1951, from May 30 to June 11, 1954, and on April 29 and 30, 1955. At least three collections from the Rincons represent most of the summer birds in museums (fig. 1). Herbert Brown, collecting at Manning Camp in July and August, 1911, mentioned in his notebook the grand scenery; Laurence M. Huey made a large collection from Spud Rock Ranger Station in June, 1932; and I took mostly House Wrens in the course of the visits reported here. I know of no published reference to birds of the Rincon Mountains other than the two following. Huey (1944) discusses a remarkable adult male hummingbird collected at Man-

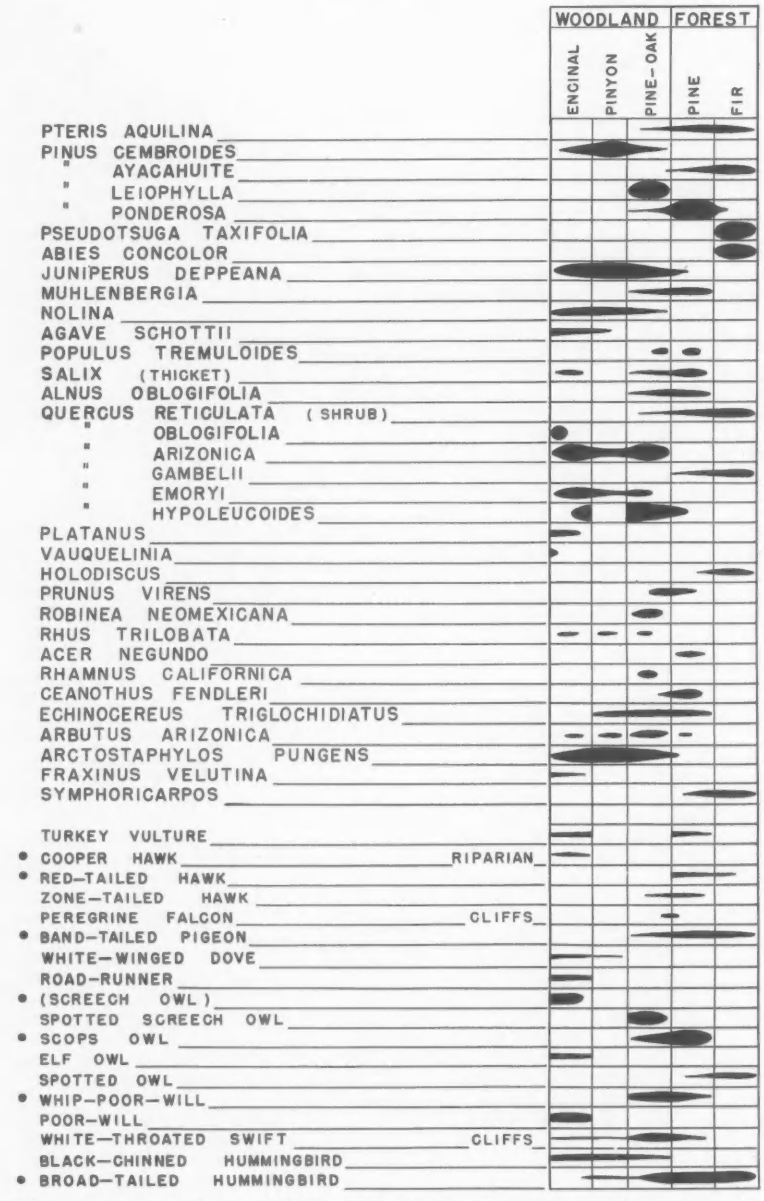

Fig. 1. Occurrence of plants and birds according to types of vegetation or other environments inhabited. A bar ending abruptly at a boundary between plant formations indicates that the bird is to be expected beyond that boundary although it was not seen there.

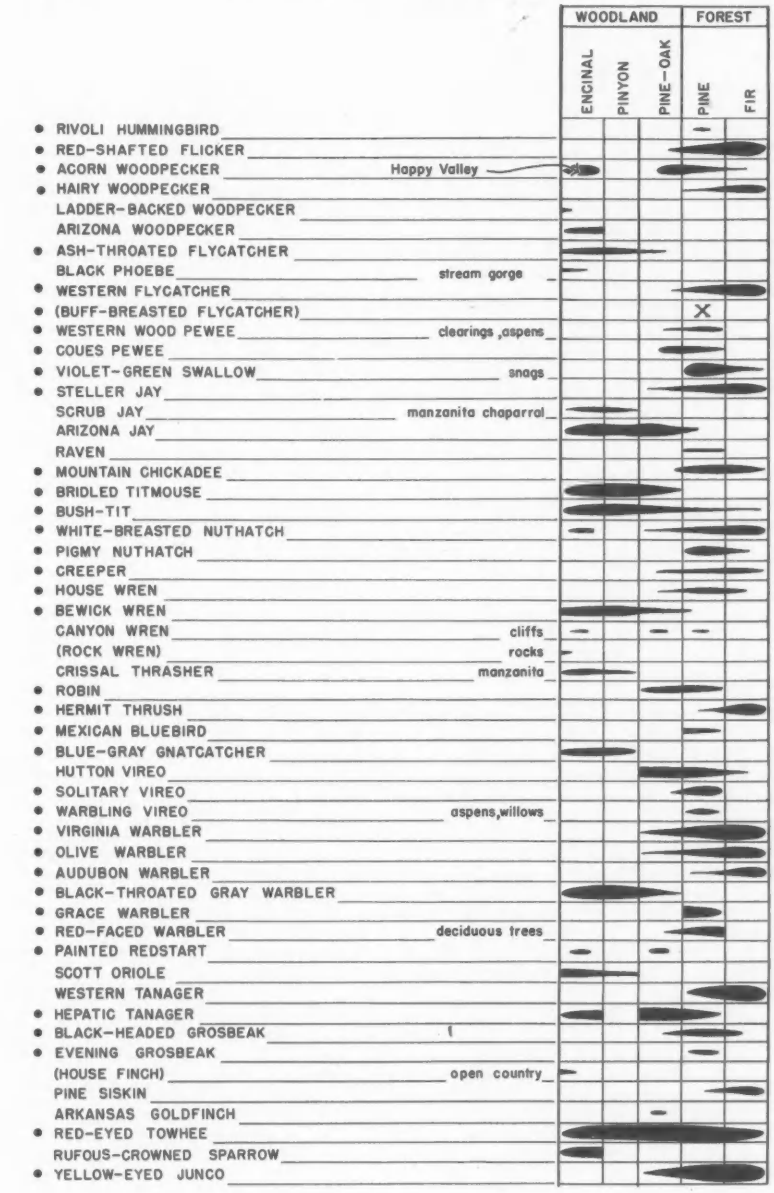

Fig. 1 (continued). A bar chopped off at left margin means that species continued down into desert. A bar at left of species name signifies specimens from Rincons extant in museums.

ning Camp in June. It is a hybrid between the Costa and Broad-tailed hummingbirds. The A.O.U. Check-list Committee (1950:369) includes the Rincon Mountains in the range of the Brown-throated Wren, *Troglodytes brunneicollis,* which was added as a species new to the check-list. In the following discussion, I propose to merge this wren with the House Wren, *Troglodytes aëdon.*

ACKNOWLEDGEMENTS

Superintendent John G. Lewis and his staff of the Saguaro National Monument made my trips possible. I am indebted also to William Fish for playing his recording of House Wren songs, to Laurence M. Huey for a copy of his field catalogue of the Rincons, and to the respective curators who facilitated my examination of specimens of Brown Creepers and House Wrens in the collections of A. R. Phillips, Saguaro National Monument, San Diego Society of Natural History, W. J. Sheffler, and the University of California at Los Angeles.

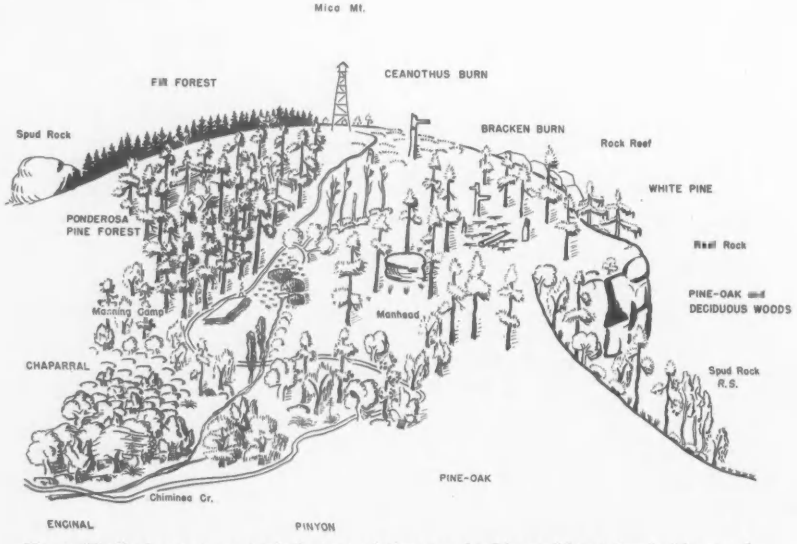

Fig. 2. Idealized arrangement of plant associations on the Rincon Mountains, looking northward. Symbols distinguish the aspen and each species of oak and conifer.

FLORA

Some of the plants important for the distribution of birds on the mountain are listed in figure 1. Ponderosa pine attains here its best development in southern Arizona, both in stature of individuals and extent of unbroken groves. (Most of these trees have needles in fives, but those of the isolated group at Grass Shack, 5300 feet, have needles in threes only.) Likewise Gambel oak and vauquelinia attain exceptionally large size in the Rincons. During my visit, the most attractive and abundant flowers were the hedgehog cactus, growing on the rocks, and the New Mexican locust, covering hillsides on the east slope with masses of blooms. Because of its intermediate position between neighboring mountains, Mica Mountain has no alpine fir, the southern limit of which

is in the Santa Catalina Mountains, and no Apache pine, a Mexican species which reaches the Santa Rita Mountains. These trees are relatively unimportant in those places and cannot account for differences in bird-life in the three mountains.

Some plants are confined to a particular slope of Mica Mountain. White fir occurs only on the northwest face, where it extends upward to within about 200 yards of the crest. Douglas fir reaches this crest, and is likewise confined to the same slope, except for three individuals near Manning Camp. I found the New Mexican locust only on the east wall of the mountain. Aspen is also prevalent there; elsewhere I found it only in a gully near Manning Camp. From Tucson a large patch can be seen part way down the northwest slope. Arizona cypress is absent from the canyons I visited.

VEGETATION

In two respects the vegetation of Mica Mountain differs from that of the Santa Catalina Mountains (Shreve, 1915). First, each major plant grouping is "all in one piece" (fig. 2). All the fir forest is on the northwest slope; the ponderosa pine forest is continuous over the broad summit; and woodland completely encircles the mountain between forest and desert. There is little if any alternation of tracts of pine forest with fir forest or with woodland, or of woodland with desert such as is found on the Santa Catalinas, whose deep canyons support contrasting vegetations on opposite walls. Second, there is a remarkable difference between the east and west slopes of the mountain. On the west, the oak woodland, except on flood-plains, is dwarfed and includes as conspicuous elements *Pinus cembroides, Juniperus deppeana, Nolina microcarpa, Agave*

Fig. 3. Spud Rock Ranger Station, 7400 feet, an area of mixed vegetation. In foreground is a wet meadow of grass and sedge surrounded by tall bracken; farther to right, past a glade of silver-leaf oaks, is a hillside of New Mexican locust overlooked by an open grove of ponderosa pines with bunchgrass. Photograph courtesy of National Park Service.

schottii, Garrya wrightii, and *Arctostaphylos pungens*—all tolerant of dryness and of terrain containing much exposed rock. But the east slope, as shown in figure 3, is a garden of deciduous shrubbery, ferns, robust trees, and a meadow. In this beautiful woodland along with the pines, aspens, and New Mexican locusts, are seen the largest oaks, madrones, chokecherries, and buck-thorns on the mountain. It is the only woods of this composition that I know of in southern Arizona. These differences were analyzed by Blumer (1910) who felt that protection of the east slope from desiccating winds explain them, at least in part.

Fig. 4. Closed encinal of Arizona oak, Emery oak, and alligator juniper on a flood-plain at Grass Shack, 5300 feet. In these and adjacent Arizona oaks, sycamores, and a Chihuahua pine, all within about 100 yards, was a series of at least a half-dozen nests of a pair of Cooper Hawks which nested in an Arizona oak in 1955. Arizona Woodpeckers, Arizona Jays, and Bridled Titmice were also conspicuous at this place, and there was a pair of Black Phoebes at the creek. This and all following photographs were taken either on April 29 or 30, 1955.

Purely for convenience the information on plant distribution in figure 1 is divided into categories corresponding with the unmixed types of vegetation in places I selected for recording birds. In order of increasing altitude these are *encinal* (oak woodland, fig. 4), some patches of *pinyon woodland* on rock exposures (fig. 5), *pine-oak woodland* (fig. 6), and *ponderosa pine forest* (fig. 7). Down the northwest slope is a *fir forest* (fig. 8) whose transition from ponderosa forest is abrupt in spite of blending by continuity of Mexican white pines and a scattering of ponderosa pines. Another imposing

change is from lower encinal down to desert as the blue oaks and vauquelinias yield their dominance to mesquite scrub and finally to saguaros.

Except for ponderosa pine forest, these types of vegetation occupy in pure form less area than do mixed and intergrading assemblages of plants. One senses an independence in distribution of the plant species, so that it is almost impossible to find them in the same groupings in any two places on the mountains. The reason ponderosa pine forest is such a well-defined environment is that it is composed essentially of one species, *Pinus ponderosa*. It is a *population*, not a community! Plant communities become reali-

Fig. 5. Pinyon pines with *Yucca schottii* and *Nolina microcarpa*. Bewick Wrens and Black-throated Gray Warblers occupied such growth.

ties only when they are so grossly defined in this area—forest, woodland, and desert—as to be of no use in describing the environment occupied by a nesting pair of birds. To illustrate how mixed-up are the vegetational features that some of the birds really select, consider again the woodland (upper encinal of Shreve) on the west slope of Mica Mountain. For about one thousand feet of altitude the monotonous rocky slope is dominated by five competing species of plants in every possible combination from equally mixed to pure stands and in a pattern determined by their individual tolerances so that no two successive acres look alike. These species are *Pinus cembroides* (which wins out on the steepest and rockiest places), *Juniperus deppeana* (numerous in individuals but with fewest pure stands), *Quercus arizonica* (dominant at higher altitude), *Q. emoryi* (dominating a few places at lower elevation), and *Arctostaphylos pungens* (most abundant of all, yet rarely able to form a pure patch, fig. 9).

Within the forest are some minor plant formations of importance to birds: willow thickets, an aspen grove (fig. 10), Mexican white pine forest, and burns covered with bracken or ceanothus.

AVIFAUNA

Mica Mountain, in the Saguaro National Monument, is an excellent place in which to see the elaborate displays of Broad-tailed Hummingbirds (*Selasphorus platycercus*), and to enjoy Coues Pewees (*Contopus pertinax*), Hermit Thrushes (*Hylocichla gut-*

Fig. 6. Pine-oak woodland, showing a small ponderosa pine, alligator juniper, Arizona oak, silver-leaf oaks, and bunchgrass. Spotted Screech Owls, Whip-poor-wills, Hutton Vireos, and Hepatic Tanagers were conspicuous at this place.

tata), Virginia Warblers (*Vermivora virginiae*), Olive Warblers (*Peucedramus taeniatus*), and Red-faced Warblers (*Cardellina rubrifrons*). Western Tanagers (*Piranga ludoviciana*) and Hepatic Tanagers (*Piranga flava*) are abundant side-by-side. I was impressed especially by the reverberating mournful cries of Peregrine Falcons (*Falco peregrinus*), the fearful grace of a Red-tailed Hawk (*Buteo jamaicensis*) stooping time and again at a frightened, but not speechless, Raven (*Corvus corax*), and by the assemblage of birds nesting in holes of snags in a burned place in the forest. Illustrative of the long distance that the Spotted Owl (*Strix occidentalis*) roams, a male was once attracted to Manning Camp; doubtless it came from the north side of Mica Mountain, more than two miles away, where the pair roosted. Several years ago a pair frequented the same camp, for Mr. Sam King, then superintendent of the monument, regularly

noted them there. Scops Owls (Flammulated Owl, *Otus flammeolus*) were hard to find, possibly because absence of moonlight suppressed their singing; but one morning I luckily saw several foraging almost until sunrise. Their astonishing vigor of flight was evident, also the launching at seeming full speed, and the abrupt landing which would cause the ponderosa pine limb to shake a few seconds. But the most memorable show was put on by a White-throated Swift (*Aëronautes saxatalis*) which swept repeatedly past our pack train. Rangers Steele and Zerbey said these swifts often follow the train,

Fig. 7. Ponderosa pine forest near Manning Camp, where Scops Owls, Pygmy Nuthatches, Solitary Vireos, and Grace Warblers were frequent.

apparently to catch flies which accompany the animals. Nevertheless, I was certainly startled each time the bird swished by within a yard of my head. I was amused, on account of our labored progress up an incline, to see it maneuver far out over the mountainside in order to plan, aim itself, and get up speed for its dash at the proper time when we were not screened by foliage.

The breeding birds and their distribution by various kinds of environments are listed in figure 1, which includes only the birds I personally saw, plus the specimen of the Buff-breasted Flycatcher (*Empidonax fulvifrons*). An estimate of absolute abundance is represented by the height of the black spot; for example, the Red-tailed Hawk, seen frequently, is represented by a thin line to account for only two individuals, whereas the broad spot for the Scops Owl connotes nine males seen and heard one morning along three-fourths of a mile of trail. Because of their continued presence during the first half of June, these birds are presumed to breed on the Rincons, although eggs, nests,

or young were not seen for all these species. But the Turkey Vulture (*Cathartes aura*), Zone-tailed Hawk (*Buteo albonotatus*), Bush-tit (*Psaltriparus minimus*), Pine Siskin (*Spinus pinus*), and Arkansas Goldfinch (*Spinus psaltria*) may not have nested in the zone indicated. Many Bush-tits were possibly up-hill wanderers, for their span of vegetation types and altitude was greater than expected. Indeed more than once they were encountered within the fir forest. Pine Siskins in a large flock created a din of song, but perhaps were not nesting; and the Arkansas Goldfinch might nest much later than my visits. The birds in parentheses in figure 1 were not found in the breeding season, but

Fig. 8. Fir forest, showing white firs and deep shade of a spot identical to that used as a roost by a pair of Spotted Owls. This is the habitat of the Hermit Thrush and Yellow-eyed Junco.

the Screech Owl (*Otus asio*), Rock Wren (*Salpinctes obsoletus*), and House Finch (*Carpodacus mexicanus*) would doubtless find a congenial summer home at Happy Valley, where I saw them in January. Herbert Brown collected a juvenal Buff-breasted Flycatcher at Manning Camp on August 18, 1911. Its parents could have inhabited the ponderosa pines there; their niche would then have been the same as that of the abundant Western Flycatcher (*Empidonax difficilis*).

Most birds listed in figure 1 depend on some attribute of the kinds of vegetation listed at the top of the chart. Others choose another type of environment, as indicated by the special notations within the several vegetation areas. The hoped-for refinement derived from subdividing woodland did not materialize except to show that some forest birds descend to pine-oak woodland because of the pines, whereas other encinal birds ascend to it because of the oaks. Otherwise such differences as appear in figure 1, among

these very arbitrary categories of woodland, will probably disappear as further observations reveal greater continuity in distribution of woodland birds. A bird like the Red-eyed Towhee (*Pipilo erythrophthalmus*), which spans several vegetation zones, is not thereby insensible to configurations of plants. It chooses bushes at altitudes above the desert, to which it is just as attached as is the Canyon Wren (*Catherpes mexicanus*) to rock gorges, and the Arizona Woodpecker (*Dendrocopos arizonae*) to evergreen oaks. There are only about five mountain birds not distributed according to features of vegetation; these depend upon some configuration of rock surfaces.

Fig. 9. Edge of largest patch of manzanita chaparral, about 80 yards in diameter, crossed by Manning Camp trail. Scrub Jays, Crissal Thrashers, and Blue-gray Gnatcatchers occupy this tract.

I confess that the use of a chart such as figure 1 is a cover for my ignorance of the exact requirements of many species. What, for instance, is the Acorn Woodpecker (*Balanosphyra formicivora*) choosing? Is it a suitable community roost, or abundance of tall tree trunks for nests and storage? Similarly one asks to what is the Hepatic Tanager responding? But certainly the birds actually choose their habitat; none is haphazardly distributed; no two species have exactly the same environment. Therefore we may confidently hope to find something for the Hepatic Tanager which corresponds to the dead conifers with woodpecker holes that the Violet-green Swallow (*Tachycineta thalassina*) requires for nests, or the dense groves of tall conifers essential for the Hermit Thrush and the bushes for the Red-eyed Towhee.

The imposing boundary between ponderosa pine forest and fir forest helps us to appraise the unique requirements of several species. In the nearby Catalina Mountains, the two types of forest interlace because of complicated topography. For instance, at Bear Wallow, Olive Warblers and Grace Warblers (*Dendroica graciae*) flit from one side to the other of the picnic ground, in and out of patches of timber that are predomi-

nantly firs or are mostly pines. But on the Rincons, as one passes from ponderosa forest into the solid stand of firs, he definitely leaves behind the Coues Pewee, Solitary Vireo (*Vireo solitarius*), and Grace Warbler and he is impressed by the striking increase in numbers of the Flicker (*Colaptes cafer*), Hairy Woodpecker (*Dendrocopos villosus*), Western Flycatcher, White-breasted Nuthatch (*Sitta carolinensis*), Hermit Thrush, Virginia Warbler, Olive Warbler, Audubon Warbler (*Dendroica auduboni*), Western Tanager, and Yellow-eyed Junco (*Junco phaeonotus*). The change from woodland down into desert has a greater effect on the birds, for it can be seen in figure 1 that at least eleven important woodland species do not descend below the oaks.

Fig. 10. Aspen grove near Manning Camp, looking southwest on the second House Wren territory. The dark trunks belong to Gambel oaks. Snowberry becomes conspicuous as an undergrowth when in leaf later in May.

One environmental feature, the brush- or bracken-covered burn, causes a simultaneous increase in several kinds of birds, although each requires a different feature of habitat. The Pygmy Nuthatch (*Sitta pygmaea*) finds suitable nest sites in the soft wood of the upright snags; the House Wren (*Troglodytes aëdon*) uses the woodpecker holes for nests and feeds in the brush and under the fallen logs; Mexican Bluebirds (*Sialia mexicana*) abound because of the woodpecker holes in these snags for nesting, together with the open space for feeding; and the Red-eyed Towhee prevails because of the dense low growth.

The Rincons differ somewhat more in their avifauna from the Catalinas and Santa Ritas than these do from their neighbors. The Pinaleno Mountains resemble the Catalinas, and the Santa Ritas and Huachucas are practically identical in their birds. In

common with the Catalinas, and unlike the Santa Ritas, the Rincons contain the Mountain Chickadee (*Parus gambeli*), the Mexican Bluebird, Warbling Vireo (*Vireo gilvus*), and Audubon Warbler; and they lack the Pygmy Owl (*Glaucidium gnoma*), the Nighthawk (*Chordeiles minor*), and Eastern Bluebird (*Sialia sialis*). Of these, the chickadee finds its southern outpost on the Rincons. Both the Rincon and Santa Rita mountains lack the Red-breasted Nuthatch (*Sitta canadensis*), Golden-crowned Kinglet (*Regulus satrapa*), and Orange-crowned Warbler (*Vermivora celata*)—all of which reach their southern limits for this region in the Catalinas. In view of similarities in vegetation on the three mountains and the short distances separating them, these facts resist a ready explanation. There are some southern species which I did not find on the Rincons. I believe they may be found in the following areas which I did not visit: the north slope of Mica Mountain above Italian Ranch, where deep woods should be encountered; the wild rugged country of Rincon Peak to the south; the open pine stand at Happy Valley saddle; and, of greatest importance, the large continuous stands of sycamores within the tall encinal in gullies descending to Happy Valley. These birds are the Turkey (*Meleagris gallopavo*), Mearns Quail (*Cyrtonyx montezumae*), Blue-throated Hummingbird (*Lampornis clemenciae*), Elegant Trogon (*Trogon elegans*), Sulphur-bellied Flycatcher (*Myiodynastes luteiventris*), and Olivaceous Flycatcher (*Myiarchus Tuberculifer*).

RACIAL BOUNDARIES

The Rincons are also unique in possessing populations of the Creeper and House Wren which are intermediate between well-marked geographic races to the north (including the Catalinas) and to the south (including the Santa Ritas). Figure 11 portrays this for the Creeper (*Certhia familiaris*). This is intended to show the reader at one glance the dorsal and ventral views of 83 Creepers. It can be seen that north of the Rincons Creepers are long-billed, white-bellied, brown-backed, and yellowish-brown rumped; whereas to the south they are short-billed, sooty on the belly, blackish-brown on the back, and deep chestnut on the rump. The Rincon birds show what seems to be a random mixture of the contrasting characters so that the population is intermediate. Note that an intermediate specimen is not "medium-long" billed, "tawny-chestnut" on the rump, and "light sooty" on the belly, but instead is apt to be short-billed, pure white, and chestnut, or some other combination of extremes. Some of the specimens are from a season when their plumage is worn, and their colors, except for the rump, are hard to classify. Racial variation in color and proportions correlated with geography is of course a feature common to many animals, but the exceptional thing here is the abruptness of the change over such a small distance, with uniformity of characters prevailing far to the north and south of the Rincons.

Color variation in House Wrens follows a more normal pattern (fig. 12) with gradual reduction in frequency of brown-throated individuals north of central Sonora. But again the Rincons play a decisive role, for Mica Mountain is the farthest point in a northwest direction where wrens with intensely buff throats and light superciliary stripes can be found. The Pinaleno Mountains constitute a similar outpost between the Chiricahua and White mountains, for the single specimen I have seen from there (U.S. Nat. Mus.) has a buff throat and breast. Unlike the color categories of rump and underparts used for Creepers, those of the wren are arbitrary, for there is gradation from light buff to orange-brown underparts. Back color, which becomes somewhat browner southward, is not shown because these are summer birds whose back color is confused by wear.

Brandt's (1945) recent discovery of these wrens with brown throats and whitish superciliaries in the Huachuca Mountains was a noteworthy event, for it added to the United States avifauna a new kind of bird, known previously only from México. It is

often a matter of opinion whether to regard two related populations of birds as the same or different species, and Brandt was not alone in considering his find as a species distinct from the House Wren, known as the "Brown-throated Wren." I shall offer evidence to support my opinion to the contrary.

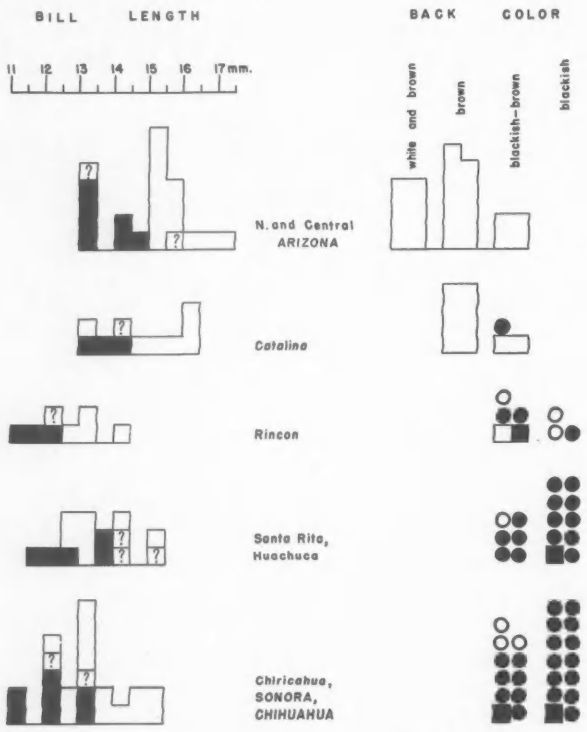

Fig. 11. Geographic variation in the Creeper, *Certhia familiaris*. Five groupings of specimens arranged from north to south. At left, measurement of culmen from tip to beginning of feathers; each square represents an individual; solid square, female; open square, male; question mark, sex in doubt. On right, coloration; round symbol, chestnut rump; square, tawny rump; white means white underparts; black, sooty underparts contrasting with pure white throat. Upper two populations represent *Certhia familiaris montana* of A.O.U. Check-list; lower three, *Certhia familiaris albescens*.

Membership of pairs of wrens, shown by corresponding numbers on figure 12, proves that choice of mates is not based on color. Also, brown-throated individuals are distributed at random through the same habitats and altitudes as those of opposite color. For instance along 300 yards of the gully of aspens near Manning Camp, the following birds were noted from west to east on four consecutive territories. The birds were on the north slope of the mountain among boulders and fallen trees and in *Symphoricarpos* shrubbery beneath the aspens, which were leafless due to damage by caterpillars. Males

sang from high in aspens or the few white pines; nests were in woodpecker holes in dead aspens. (Numbers are from my specimen catalogue, and colors refer just to the throat and chest.) First was a male (4603, whitish) displaying before a female (4604, gray-flecked) which looked into the nest and returned to it later. During this time a

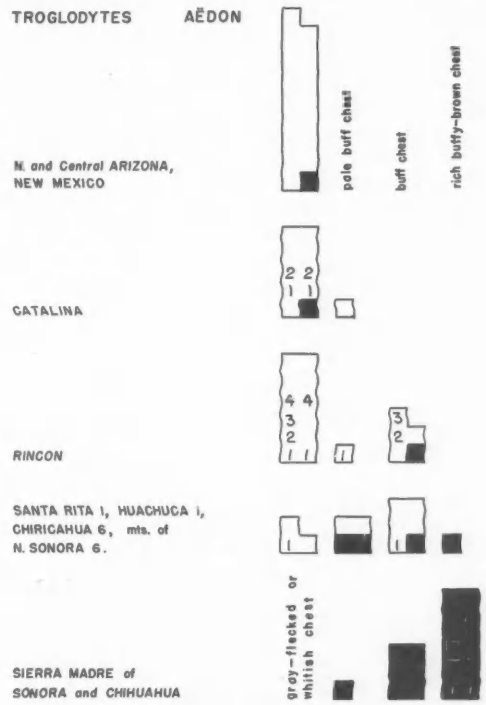

Fig. 12. Geographic variation in the House Wren, Troglodytes aëdon. Four vertical columns represent, from left to right, four arbitrary degrees of brownness (the first, no brown) on chest in worn summer skins cleaned with carbon tetrachloride. Each small square represents an individual; solid square signifies a conspicuous whitish superciliary line. Birds with same numeral are members of a pair or *ménage à trois*. These five populations, from north to south, have been known previously as *Troglodytes aëdon parkmanii, T. a. parkmanii, T. brunneicollis vorhiesi, T. b. vorhiesi,* and *T. b. cahooni.* They are here considered to be conspecific under the name *Troglodytes aëdon.*

second female (4605, buff) was sitting in this same nest. The next territory contained a male which seemed whitish at the great height from which he always sang. He began singing long brilliant songs an hour after the pair in the third territory was collected, and he began also to include their region in his song circuit. The pair collected in the third territory consisted of a whitish male (4609) and a female with rich buff throat and chest (4610) taken at their nest. The fourth territory was occupied by a rich buff male (4589, collected June 1) and two other dark looking birds, at least one of which

frequented the nest tree in which two nests had been started, four feet apart. The next day a light gray male was present and was flushed June 3 from the principal nest; he used different song perches. On June 10 his territory had shifted a little to accommodate a new female who hailed from the opposite side of the gully. Both members of this pair proved to be the light gray type (4611, 4612).

Those who credit the "Brown-throated Wren" of southern Arizona with a distinctive song are comparing it with the House Wren of the eastern United States. Recordings of California birds, made by Dr. William Fish, sound identical in pattern and quality with my carefully memorized and written notations of the southern Arizona birds, although they are not always as long. Length of song varies greatly during the nesting cycle, just as does the secretiveness of the bird. There is, however, a gradual change in voice southward so that in the Sierra Madre of Sonora and Chihuahua the songs are longer and more musical. Only on the *average* is this true, for House Wrens at Summerhaven in the Catalinas frequently indulge in long brilliant songs delivered from high on a ponderosa pine branch—in setting and virtuosity identical with Sierra Madrean birds even to the elegant coda of chromatic phrases. Recordings may in the future prove that the difference in the two extremes of this wren's song (geographic as well as individual) is merely one of time intervals between the same successive notes which makes one a jumble, the other a charming musical performance. If the songs of brown-throated and white-throated wrens were so unlike that we and the female wrens could tell them apart, and further if the female wrens would not recognize the singer of opposite color type as a potential mate, then our wrens might be different species because they would not interbreed. But we find no such differences either as we turn from a white- to a brown-throated male's performance, or as we travel from the Catalinas to the Huachucas.

The eggs and nest construction are identical in all these wrens. I inspected six nests in the Rincons and two in the Sierra Madre Occidental (one near Huachinera, Sonora). These are of the usual House Wren construction wherein twigs fill the woodpecker hole to its brim, and the nest is oriented on the vertical axis of the hole, as the confined space demands. An occasional nest built off-center (*cf.* Brandt, 1951) is only an individual variant. I saw one in a natural oak cavity, open at the top, in the Sierra Madre of Chihuahua. Sensibly enough the nestlings were ensconced far to one side so as not to be pelted by torrents of rain. Brandt's (1951:678) measurements prove that eggs of the buff-throated House Wrens are the same size as those of eastern and western races of the House Wren when compared with the figures of Bent (1948:122, 144). Their color is also the same, as revealed by two sets of eggs, one of which I collected in the Rincons (male parent gray throat, female buff throat) and the other in the Sierra Madre of Sonora (both parents buffy-brown). Thus the objections to regarding *Troglodytes brunneicollis* (Brown-throated Wren) as conspecific with *Troglodytes aëdon* (House Wren), are, I believe, dispelled.

SUMMARY AND CONCLUSIONS

Simple topography of the Rincon Mountains provides that some contrasting aggregations of plants occupy mutually exclusive areas on different faces of the mountains. For southern Arizona the boundaries of these plant formations are vivid; particularly is this true of those between desert and woodland and between ponderosa pine forest and fir forest. Such a radical difference between adjacent plant environments marks the tolerance limits of several species of birds simultaneously so that of 25 species dwelling within encinal vegetation, 13 do not enter desert; of 40 species inhabiting ponderosa pine forest, at least 3 do not enter the fir forest, whereas 10 species gain in abundance within the firs. Unexpectedly, in view of their geographic position and proximity to sister

mountain ranges, the Rincons are crucial in the distribution or racial variation of several kinds of birds, of which the Mountain Chickadee, Creeper, and House Wren are examples. The House Wren's variation on the Rincons is interpreted here as proof that it and the "Brown-throated Wren" are the same species.

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A HYBRID JAY FROM CHIAPAS, MEXICO

By FRANK A. PITELKA, ROBERT K. SELANDER, and MIGUEL ALVAREZ DEL TORO

In January, 1951, a lone and peculiar jay was observed and collected by Alvarez del Toro at Santa Rita in western Chiapas (fig. 1). It appeared more robust than the locally common Magpie-jay (*Calocitta formosa*) and behaved differently from it. The locality, northwest of Tuxtla Gutiérrez, is five miles north of San Fernando, a small village recently renamed Villa Allende. The specimen was sent to the Museum of Vertebrate Zoology, and the interest aroused by it resulted in several visits to the area by Alvarez del Toro and Selander, in 1953 and 1954. Their efforts were directed toward obtaining information on geographic and ecologic distribution of the jays locally present and, if possible, further specimens which would help unravel the mystery presented by the one which Alvarez del Toro collected.

Because the Santa Rita specimen superficially resembles *Calocitta* more than any other jay (see fig. 2), it was first thought that it could be a variant of the dark type of *C. formosa* which occurs in increasing proportion in populations west of Chiapas. Between the black-throated, dark-faced race (*C. f. colliei*) occupying the northwestern end of the species' distribution and the westernmost of the white-throated, light-faced races (*C. f. formosa*), there occur individuals combining color characters of these forms in various ways. This is in an area over which the distribution of Magpie-jays is virtually continuous. Even the main features of this intergradation are not known yet, but the mixed characters of specimens from this area, and particularly the incidence of contrasting individuals in single populations, indicate that the changes from the "*formosa*" type to the "*colliei*" type are manifest in fairly complex manner over an area that is large. Hence the view that the Santa Rita specimen might represent some extreme expression of this situation.

Two other possible explanations for the peculiarities of this specimen were at first also entertained. It could be a hybrid between *Calocitta formosa* and *Psilorhinus mexicanus*. This possibility arises from the fact that the area in which the specimen was taken is one of the few where the distributions of these two large lowland jays meet and overlap (fig. 3).

The last explanation was simply that we were dealing with a new species of jay, and in the light of the train of relatively recent surprises offered by the Mexican avifauna, this hypothesis did not seem to be too far-fetched. There are nine species of jays in the region of the Isthmus of Tehuantepec, and one more conceivably could occur. Witness the presence of *Cyanocorax dickeyi* in western México and of other species with similarly restricted distributions elsewhere in México and Central America. Field explorations by Selander, however, disclosed no habitat conditions which would strengthen the notion that a new species was involved. From October 10 to 21, 1953, and again from April 25 to 30, 1954, the area was examined by him to see if there were any habitat with distinctive features of vegetational structure and of substantial area, or if there were any patterns of habitat interspersion peculiar to the area, which could be the domain of the strange jay. No such situation was found, and although additional specimens of both *Calocitta* and *Psilorhinus* were collected, all these were normal. As no definite evidence of still a third kind of large jay in the area was obtained, the possibility that the Santa Rita specimen represented a new species was dismissed.

Closer study of the specimen has led us to dismiss also the view that it is merely a variant of *Calocitta*. Rather, the totality of facts appears to favor the view that it is a hybrid, and the information now to be given is organized on this assumption.

MORPHOLOGICAL CHARACTERS OF THE HYBRID

In color, the Santa Rita specimen, an adult male, is more or less intermediate in most characters, and indeed perhaps in all characters depending on one's interpretation of variational range and character recombination.

The back is dull bluish slate gray, falling fairly midway between the grayish blue of *Calocitta* and the brown of *Psilorhinus* taken in the same region. The upper surface of the rectrices is slate blue, likewise fairly intermediate between the dark purplish blue of *Calocitta* and the brown of *Psilorhinus*. Contrast between back and rectrices is marked

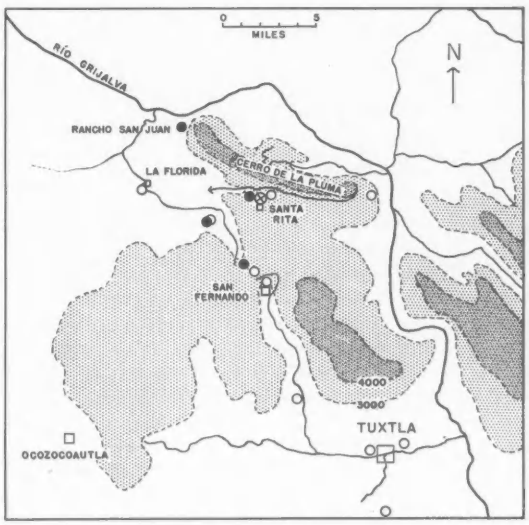

Fig. 1. Map of area north of Tuxtla Gutiérrez, Chiapas, showing localities mentioned in text; circles indicate records of *Calocitta*, dots indicate records of *Psilorhinus*, and circle with cross shows locality where hybrid was collected. Elevational contours shown in feet.

in *Calocitta* and virtually nil in *Psilorhinus*, and the Santa Rita specimen falls between them. Rectrices 3 to 6 are white-tipped, as is true of both *Calocitta* and *Psilorhinus*, but the area of the white tips is comparable to that of *Calocitta*, hence not intermediate. Rectrices 2–2, white-tipped in *Psilorhinus* but not in *Calocitta*, are so colored in the Santa Rita specimen but only partly, and hence are intermediate.

Characters of color and pattern in which the Santa Rita specimen deviates from both *Calocitta* and *Psilorhinus* occur on the head, which is black except for the white-throat patch already mentioned, a broad grayish-white superciliary stripe, and a poorly defined whitish triangular malar patch (see fig. 4). On these light areas, flecks of black and blue occur except in the fore-part of the malar patch, which is clear white tinged with blue. While it is stated that these characters are deviations, it should be admitted that within the interpopulational genetic substrate controlling the widely varying color pattern of the head of *Calocitta*, the pattern seen in the Santa Rita specimen could probably

arise, and evidently the overall darkening is still further indication of the influence of *Psilorhinus*.

The crest characters, at first appearing unique, are perhaps easily regarded as the result of interaction between genetic controls in two parent jay species with markedly dissimilar crests. *Calocitta* has a long, recurved, and erectile crest arising alone from frontal crown feathers; it lacks bristly frontal feathers. *Psilorhinus* is crestless but has bristly frontal feathers that form a slight crest. The Santa Rita specimen has a short frontal crest of feathers which are neither so bristly as in *Psilorhinus* nor possessed of

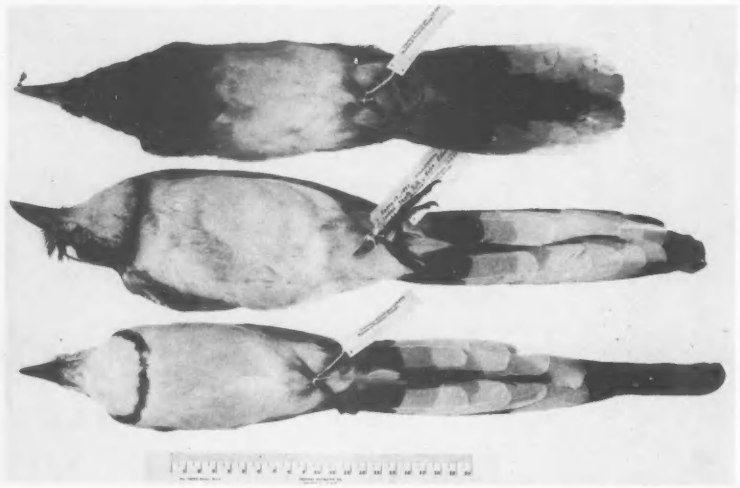

Fig. 2. Specimens of jays, all adults, collected north of Tuxtla Gutiérrez, Chiapas; top to bottom, Brown Jay (*Psilorhinus mexicanus*), hybrid, and Magpie-jay (*Calocitta formosa*); scale in centimeters.

so well-developed vanes as in *Calocitta*. In some respects the crest is reminiscent of that of *Cissilopha san-blasiana* in its first-year plumage, and of several species of the genus *Cyanocorax, sensu* Amadon (1944).

For size comparisons, because of present uncertainties concerning certain aspects of variation in both *Calocitta* and *Psilorhinus*, we have preferred to compare the Santa Rita specimen only with specimens of the parental species taken in the same general area, even though these are few. The results are given in table 1. Although more data are needed, particularly for *Psilorhinus*, the available figures give no reason for thinking the Santa Rita specimen is anything but more or less intermediate again, or actually closer to *Psilorhinus* as suggested by wing size and by the closer approach of some of the other figures to *Psilorhinus* than to *Calocitta*. The figure of 202 mm. for wing chord of the Santa Rita specimen will surely fall within the range of variation for this character in a good sample of *adult males* of *Psilorhinus*. The bird's weight was not recorded.

A character of *Psilorhinus* apparently unique among jays is the presence of a furcular pouch (Sutton and Gilbert, 1942) which is inflated to produce a characteristic "hiccuping" note. Unfortunately, a detailed examination of the interclavicular region of the hybrid specimen was not made at the time it was prepared as a study skin. How-

ever, examination of the dried specimen quite clearly indicates that while a fully formed pouch was not present, the skin of the interclavicular region is thicker and less pliable than that of specimens of *Calocitta*, suggesting that a partly developed pouch was present.

Table 1

Measurements of Jays from Western Chiapas

	Calocitta[1]	Hybrid[2]	*Psilorhinus*
Wing chord	184.9 mm. (176–191[1])	202 mm.	195,[3] 185[4] mm.
Tail length	277.0 (255–292)	248	195, 199
Tarsus	42.5 (39.6–44.4)	46.7	48.6, 48.1
Bill length	23.2 (22.1–24.1)	27.8	27.3, 28.8
Bill depth	13.4 (12.7–14.0)	15.5	16.5, 15.7
Crest	63 (60–68)	25	5±

[1] 8 specimens; 3 only for crest; all adult males.
[2] Adult male (testes not measured) taken January 10, 1951, at Santa Rita, 3000 feet, 5 miles north of San Fernando, Chiapas, M. A. del T. number 296, M.V.Z. no. 126534.
[3] Adult female.
[4] First-year male.

It is worth noting that according to the sequence of plumages determined for jays of the genus *Aphelocoma* (Pitelka, 1945) and since then found to be characteristic of all other American jays, the hybrid has undergone at least one complete molt. It was therefore at least one and one-half years old when collected.

DISTRIBUTION AND HABITAT OF *Calocitta* AND *Psilorhinus*

There are two principle types of vegetation in western Chiapas near Tuxtla Gutiérrez and in the hills north of the Tuxtla Valley, arid tropical forest and tall subdeciduous forest (Miranda, 1952:87, 103). Arid tropical forest is low, composed in large part of deciduous thorny species of leguminous trees or large bushes. It extends more or less continuously northward at least to the town of San Fernando, to an elevation of about 2500 feet. It also occurs again in canyons on the northwest slopes of the mountains north of San Fernando, between 1000 and 2500 feet, as at La Florida. This is a Pacific-slope floristic complex fingering northward across the isthmus and represented by such marginal, disjunct areas as that at La Florida. *Calocitta* is a bird characteristic of this vegetation in the central depression of Chiapas and along the Pacific coast generally.

Tall subdeciduous forest is similar in appearance to the rain forest of Caribbean lowlands, but according to Miranda (1952:87), the deciduous habit is more marked and the leaves are lost for longer periods than in true evergreen forests closer to the Caribbean coast. In height, this vegetation is similar to rain forest; in composition it includes some species characteristic of rain forest and others characteristic of arid tropical forest. Hence the tall subdeciduous forest is transitional between these two types. It extends southward to near Tuxtla, along a line marked by the distributional boundary of *Bumelia persimilis*. This forest is present between 3000 and 3700 feet along its southern limits but occurs at lower elevations northward, where it blends into rain forest of the Caribbean lowlands. *Psilorhinus* is a bird characteristic of this vegetation and its margins. The Green Jay (*Cyanocorax yncas*) is also present.

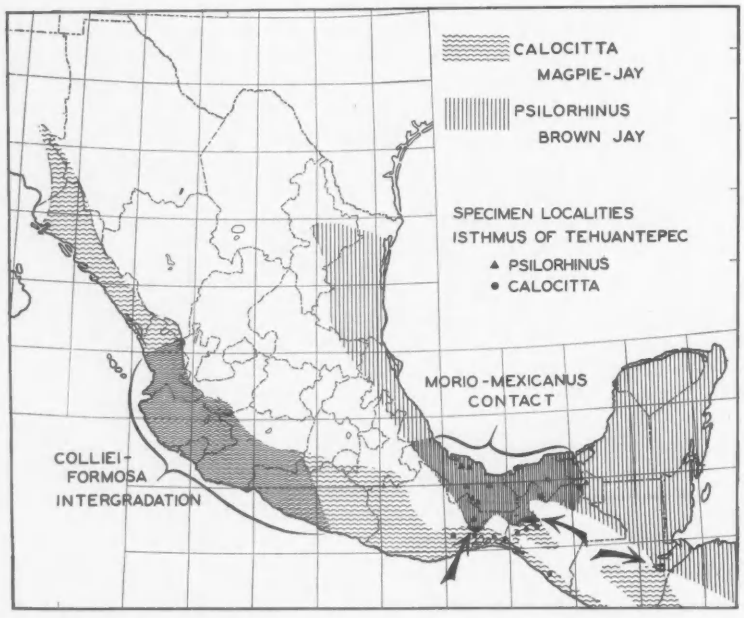

Fig. 3. Map showing distribution of the Brown Jay and Magpie-jay in México and Guatemala; localities from which specimens have been recorded are shown for the Isthmus of Tehuantepec only; areas of contact are indicated by arrows; broad belts of species contact in *Psilorhinus* and of intergradation between black-faced and white-faced races of *Calocitta* are shown only approximately.

North of San Fernando, tall subdeciduous forest occurs, or once occurred, over extensive areas between 2500 and 3500 feet. It appears that with cultivation, this forest has become restricted and, in some areas replaced by stands of more open, deciduous second-growth forest vegetation and that elements of the arid tropical forest have invaded northward and upward in the valleys to 3000 feet or higher (fig. 5).

In this contact across the isthmus between two major vegetation types, the two large lowland jays meet. *Calocitta* is common around Tuxtla and at least locally it is common northward as far as La Florida, at 1500 feet. Whether it occurs still farther north has not been determined satisfactorily. In this area, in the fall, it was observed in flocks of five to ten; in the spring it was scarcer in the mountainous region north of Tuxtla and more closely associated with the open arid vegetation at lower elevations. Occasionally it was observed along margins of the more mesic vegetation favored by *Psilorhinus*.

In the same area, *Psilorhinus*, although apparently never common, nonetheless appears to occur fairly regularly. It has been observed at various points north and northwest of Tuxtla and occurs southward to within two miles of San Fernando. In the vicinity of San Fernando, hence in this marginal southward extention of its distribution, the occurrence of *Psilorhinus* may vary seasonally. It was not seen in October, but was present in January, April, and the summer months. It is present in small numbers on the north slopes of the Cerro de la Pluma, north of San Fernando, where Alvarez

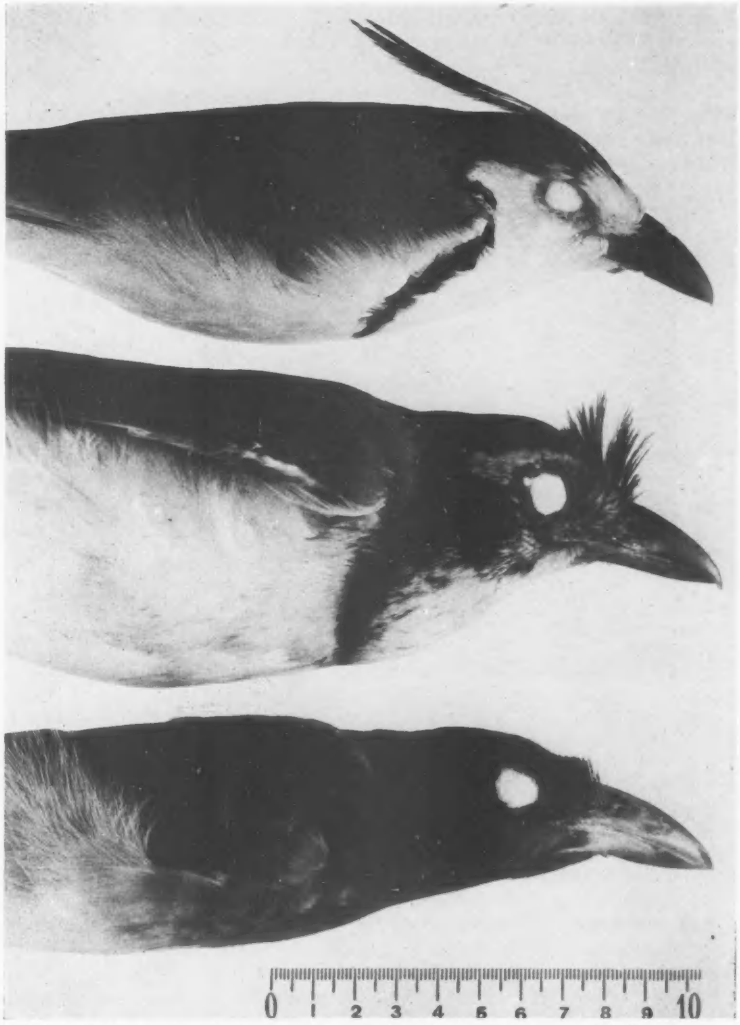

Fig. 4. Pattern and crest characters of hybrid jay (center) compared with Magpie-jay (above) and Brown Jay (below); scale in centimeters.

del Toro found a nest in April, 1953, at Rancho San Juan. Beyond these localities, toward the Caribbean along the Rio Grijalva, this species becomes increasingly common (Alvarez del Toro, MS).

Both *Calocitta* and *Psilorhinus* were observed by Selander at one time on April 28, 1954, when he was in a clearing in disturbed tall subdeciduous forest five miles northwest of San Fernando, but neither on this occasion nor any other recorded by him or

Alvarez were the two species seen in close association. Nonetheless, as *Psilorhinus* frequents the edges of the tall mesic forest, and as the remnants of this vegetation are interspersed with arid forest and clearings frequented by *Calocitta*, the two can easily come into contact.

Thus, there is ample ecological evidence of opportunity for *Calocitta* and *Psilorhinus* to meet and evidently also to interbreed if the Santa Rita specimen is correctly regarded as a hybrid. At this time, we see no possiblity of another conclusion. Modifications in local vegetational pattern wrought by clearing of land and farming activities north of

Fig. 5. Habitat in area of overlapping distributions of *Calocitta* and *Psilorhinus* between San Fernando and Santa Rita, Chiapas, elevation approximately 2800 feet. Note extent of clearing and interspersion of vegetational elements. Island of trees in upper right-hand corner is second-growth or disturbed subdeciduous forest about 50 to 60 feet high; below this are corn fields.

Tuxtla have increased and diversified the local intermingling of the two regional vegetation types. As a result, local habitat conditions here favor more frequent contact between *Calocitta* and *Psilorhinus* than was true earlier.

In view of the fact that other areas of contact are known, it would seem incorrect to regard the one north of Tuxtla as a purely recent development, hence our statement that agricultural activities have merely *increased the frequency* of meeting between the two species there.

At least at three other points in the distributions of *Psilorhinus* and *Calocitta* the two are known to meet. There is one contact in eastern Oaxaca, at Matias Romero north of Tehuantepec (L. Irby Davis, in conversation; and Skutch, 1953:68) and another in the Motagua Valley of Guatemala between Gualán and Quiriguá (Skutch, *loc. cit.*). Both of these are shown in figure 3. Although *Psilorhinus* remains a species of Caribbean slopes and lowlands over most of its distributional area, in the southern parts of its range, at least in Costa Rica (Carriker, 1910:774–775, and Skutch, *op. cit.*: 69), it occurs on both Caribbean and Pacific slopes. Here *Psilorhinus* and *Calocitta* evidently intermingle more than anywhere else.

We now have a case of a hybrid produced between two superficially so dissimilar

species as *Calocitta formosa* and *Psilorhinus mexicanus,* in a passerine family in which naturally occurring hybridization is rare. The specimen proves to be of special interest as evidence bearing on questions of relationships among American jays (Pitelka, MS), and while this is not the place to wander in phylogenetic speculation, one point may be mentioned. The *Cyanocorax-Psilorhinus-Calocitta* section of the American jays (Pitelka, 1951:203) is more closely knit than recent taxonomic treatments indicate, and in any case the generic limits now recognized do not reflect the pattern of phylogenetic radiation shown by preliminary study of the members of these genera. Amadon's (1944) review of the genera of Corvidae has already indicated need for certain changes. The event of this hybrid would seem to suggest, for example, that *Psilorhinus* and *Calocitta* are not so divergent as their taxonomic isolation in separate genera indicates. Also, notice may be taken of the remarks of Skutch (1953:69–70) and Carriker (1910:775), who comment on similarity of call-notes between *Psilorhinus* and *Calocitta*. Selander's observations are in agreement. Finally, it is perhaps more than coincidence that these two "genera" are so allopatric as they are and that contact points involve such small areas of overlap. In this connection ecologic distribution and habits of these jays as manifest in Costa Rica would be worth comparing with those of segregated populations to the north. It may be added that in the western part of the Pacific slope of Guatemala, where *Psilorhinus* is absent, Skutch (1953:69) reported that *Calocitta* occurs at elevations up to 3700 feet "and here resides in a region where . . . abundant rainfall has produced forests as heavy as those of the Caribbean slope."

SUMMARY

A hybrid between the Magpie-jay (*Calocitta formosa*) and the Brown Jay (*Psilorhinus mexicanus*) is reported from western Chiapas. It was a male and was fully adult by plumage characters used for jays. In most characters of color and pattern, the specimen is more or less intermediate even though the supposed parental species are conspicuously dissimilar. In size, it is also intermediate. The locality where the hybrid was obtained is one of the four known areas of contact between *Calocitta* and *Psilorhinus*. Modification of habitat is considered to have facilitated the association of these species with each other. The event of hybridization between *Calocitta* and *Psilorhinus* supports recent views that these two "genera" are more closely related than is indicated by earlier taxonomic reviews of American jays.

ACKNOWLEDGEMENTS

The field work undertaken by Selander in 1953 and 1954, concerned only in part with the distribution of jays in western Chiapas, was supported by grants from the Associates in Tropical Biogeography of the University of California, and we express our appreciation to them. Alvarez's field work was conducted under the auspices of the Instituto Zoológico del Estado, Tuxtla Gutiérrez, Chiapas. In the field, Selander received much effective assistance from Bonifacio Guillen Moreno. Finally we are indebted to the authorities of the Government of México, in particular to the Dirección General Forestal y de Caza, under the Secretaría de Agricultura y Ganaderia, and to its representative, Ing. Juan Lozano Franco, for permission to collect specimens.

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THE BIRDS OF THE REVILLA GIGEDO ISLANDS, MEXICO

By BAYARD H. BRATTSTROM and THOMAS R. HOWELL

The Revilla Gigedo Archipelago consists of a group of four volcanic, oceanic islands that lies southwest of Baja California, México. The archipelago is situated between 18° 20′ and 19° 20′ north latitude and between 110° 45′ and 114° 50′ west longitude. The islands are, in order of increasing size, Roca Partida, San Benedicto, Clarión, and Socorro. Although uninhabited, they are governed by the Mexican state of Colima. The island nearest to the mainland lies 210 miles southwest of the tip of Baja California.

Roca Partida is about 300 feet long and 25 feet wide; it has two small peaks 75 and 100 feet in height. No terrestrial vegetation is present and only sea birds roost or nest there.

San Benedicto is about four miles long and one and one-half miles wide. It had a limited flora and fauna, including one form of endemic land bird, but virtually all its biota was destroyed in 1952 by the eruption of a new volcano on the island.

Clarión is about six miles long and four miles wide. The vegetation consists of low scrub and prickly-pear cactus interspersed with large areas of grass. The highest point on the island, Mount Gallegos, is about 1000 feet above sea level.

Socorro is roughly nine miles on a side. Its highest point, Mount Evermann, rises to a height of 3700 feet. The vegetation of the west, south, and east sides of the island below 2000 feet consists predominately of a thick mass of the shrub *Croton masoni* and the cactus *Opuntia engelmanni*. The north side of the island and all the higher elevations have a vegetation of broad-leaved tropical plants including *Prunus capuli, Ficus continifolia, Guettarda insularis,* and some bromeliads and orchids.

Hanna (1926) has given a general account of the islands, illustrated with maps and photographs, and Johnston (1931) has reviewed the botany of the archipelago. The major ornithological papers concerning the islands include those of Grayson (1871), Townsend (1890), Anthony (1898), and McLellan (1926); some additional references not cited elsewhere in the list to follow are Rothschild and Hartert (1899, 1902), Swarth (1933), and Taylor (1951).

There are no native mammals on any of the islands, but sheep were introduced on Socorro in 1869. Sheep are still present today, and the total population is estimated at about 2000 animals. The herpetofauna of the islands consists of two species of lizards—*Urosaurus auriculatus* on Socorro and *U. clarionensis* on Clarión—and one species of snake, the racer *Masticophis anthonyi* on Clarión. There are no amphibians or freshwater fishes present, but land crabs (*Aegecarcinus planatus*) are present on Socorro and San Benedicto.

Two temporary rain-filled ponds about 100 × 50 yards in size occur on Clarión, and one of similar size is found on Socorro. Occasionally there are streams and small pools on Socorro during rainy periods. There is a small seep in a canyon about 50 yards inland from Binner's Cove, Socorro, and there is a small spring at the water's edge at Grayson's Cove, Socorro, that is covered at high tide. No springs are known to exist on the other three islands.

The senior writer visited the Revilla Gigedo Archipelago for a month in March, 1953, and for two weeks in November, 1953, with expeditions of the Scripps Institution of Oceanography under the leadership of Mr. Adrian Richards. The first trip was aboard the research vessel *Paolina–T* and the second was aboard the *M/V Crest*.

The itinerary of the two trips was as follows:

Left San Diego, Calif.	March 3	Nov. 13
Roca Partida	March 7–8	.....
San Benedicto	March 9–13	Nov. 17
Socorro	March 14–19	Nov. 18–21
San Benedicto	March 20	.....
Clarión	March 23–26	.....
San Benedicto	March 28	.....
Arrived San Diego	April 3	Nov. 25

A total of three days was spent on Clarión, one on and about Roca Partida, three on San Benedicto, and six on Socorro. The remaining time was spent around each of the islands making bathymetric surveys.

Fig. 1. San Benedicto Island before the eruption of El Boquerón volcano. Herrera Crater is on the right and the "Ash Heap" on the left. El Boquerón now fills the valley between the "Ash Heap" and Herrera Crater. Photograph by G. D. Hanna in 1925.

San Benedicto Island has been of particular interest in recent years because of the eruption of a new volcano, El Boquerón (fig. 2), on August 1, 1952. The eruption began in a large valley between an old crater, Herrera, and the so-called Ash Heap at the southern part of the island. The volcano completely filled the valley, and by August 14 it had built up a cone 1000 feet high. It erupted again on November 1 and December 8, 1952. On December 8 it broke through at its east base and poured lava into the sea. By March 9, 1953, the volcano was dormant and probably dead, although there were still fumerols in the crater and about the fissure at its base. The lava was still warm to the touch and in places so hot as to prevent walking. By November, 1953, most signs of activity were gone save for occasional sulfur fumes.

Figure 1 shows the section of San Benedicto which had the heaviest vegetation before the volcano erupted. Figure 2 was taken about 15 minutes after the start of the eruption, and figure 3 shows approximately the same area as figure 1 some weeks after the eruption.

Pumice and pumice dust covered the entire island and offshore pinnacles to a depth of three to 10 feet. This killed all the vegetation and many of the nesting sea birds;

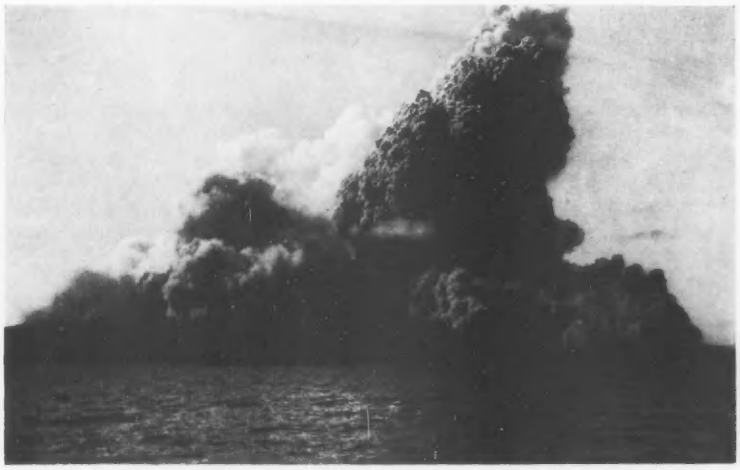

Fig. 2. San Benedicto Island approximately 15 minutes after the initial eruption of El Boquerón, 8:45 a.m., August 1, 1952. Photograph by Robert Petrie.

Fig. 3. San Benedicto Island today. Official United States Navy photograph, September 21, 1953.

buried skeletons, nests, and eggs were later uncovered (fig. 4). The endemic subspecies of Rock Wren, *Salpinctes obsoletus exsul,* was apparently exterminated.

In March, 1953, no wrens were found. Sea birds were numerous, but they roosted only on the sides of the north end of the island (fig. 5) and never on the fresh ash. Other than these birds, the only living things found were a few land crabs; no plants of any kind were present. In November, 1953, a great change was noted. On the north end of the island the pumice had begun to wash off the steep slopes and gulleys and young plants had sprouted. None of the older plants had survived, and all the new ones were apparently from seeds which had survived under the ash. In November, 1953, Dr. Herbert L. Mason (personal communication) found five of the ten species of plants known to have occurred on San Benedicto.

Fig. 4. Bird skeletons weathering out of ash of El Boquerón on November 17, 1953. Note unweathered ash at top of photograph and feathers on skeleton in foreground. Photograph by Herbert L. Mason.

In November, the birds were beginning to roost and nest on exposed soil in eroded areas, and boobies were found roosting on new pumice in nonwindy places. Crab holes and shearwater burrows were numerous at the north end of the island. The distribution of the birds on San Benedicto was mapped in March (fig. 5) and November. Hanna (1926) reported that the population of Lesser Frigate Birds, *Fregata minor palmerstoni,* on San Benedicto in 1925 was so high that many young were starving. The population of this species in November, 1953, was estimated at 150 to 200 birds. It will be interesting to note future changes in the numbers of nesting sea birds on San Benedicto.

In November, as in March, no Rock Wrens were seen on San Benedicto. It is conceivable that some of these birds may have flown to Socorro, 32 miles to the south, but none was seen there; there is little hope that any members of the San Benedicto population survive.

BIRDS OBSERVED IN MARCH AND NOVEMBER, 1953

The senior writer was primarily concerned with studying the reptiles of the archipelago, but he devoted as much time as possible to ornithology. Since little has been published on the habits and habitats of the resident birds of the islands, some data on these subjects are presented here. Only a few specimens were collected, and these are

now in the Dickey Collection, University of California, Los Angeles. G. Dallas Hanna collected a few specimens during the trip in November, 1953, and these are in the collection of the California Academy of Sciences, San Francisco; new records obtained were reported by Webster and Orr (1954) and are not repeated here. In the following accounts, new records for the archipelago are marked with an asterisk (*) and new records for an individual island are marked with a dagger (†).

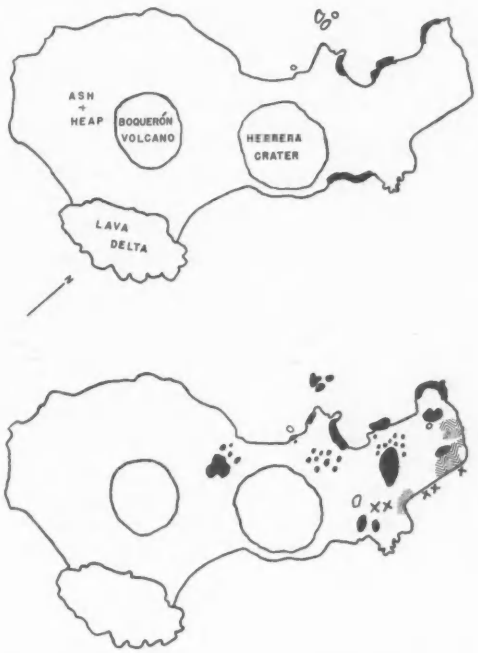

Fig. 5. Outline maps of San Benedicto Island showing locations mentioned in text and distribution of birds. Above, roosting sites of all species of birds (black areas) in March, 1953. Below, roosting sites of Blue-faced Boobies (black areas), Brown Boobies (small outlined areas on land), tropic birds (crosses), frigate birds (shaded area), and shearwaters (wavy lines) in November, 1953.

Puffinus pacificus chlororhynchus. Wedge-tailed Shearwater. This species was common about San Benedicto and Socorro, and the birds often came to the lighted ship at night. One was found dead on the beach at San Benedicto on March 11. At 5:20 p.m. on March 11, about 300 shearwaters were observed flying low over the water and feeding just south of the Ash Heap at San Benedicto. Also in the group were about 20 Blue-faced Boobies and an occasional frigate bird. By 5:30, the number of shearwaters had almost doubled. Many of them flew about the top of the Ash Heap (elevation 900 feet), their roosting site before the 1952 eruption, and then flew to the northwest side of the island. None was seen to go to the east side, where there were sulfur fumerols and fresh lava. During the following two days there were similar occurrences. The burrows of these shearwaters were evident

on the north end of San Benedicto on November 17, but no birds were seen. The Ash Heap apparently had not been used as a roosting site since the eruption in 1952.

About 10 Wedge-tailed Shearwaters were seen on March 19 around Oneal Rock, on the north side of Socorro, and about 130 were seen there on March 22. One carrying food in its beak was seen 54 miles northeast of Roca Partida on March 22; it was harassed by a frigate bird and dropped into the ocean.

Puffinus auricularis. Revilla Gigedo Shearwater. Thirty or 40 were observed at sea near the south end of Clarión on March 23, and five were seen off San Benedicto on November 17.

Phaëthon aethereus mesonauta. Red-billed Tropic Bird. Two were seen flying about Roca Partida on March 8, and the species was common at San Benedicto during the March visit. On March 13, an unusual behavior pattern was observed at the south end of San Benedicto. At 2:50 p.m., 10 tropic birds were seen flying around the Ash Heap and over the water; they were calling loudly. By 2:52 their number had doubled, and more were coming in from all directions. By 2:58, 39 birds were present. They formed loosely-knit groups of from 5 to 10 birds each, and individuals often shifted from one group to another. These groups flew in wide circles, sometimes reaching an estimated height of 500 feet. At least one or two birds in each group were calling at any given time, so that vocalization was continuous.

From groups that were flying at an elevation of about 200 feet, two birds would leave the flock and glide together, one about 12 inches directly above the other, for a distance of 100 to 300 yards down to a level about 20 feet above the water. The gliding birds would then separate and rejoin the same or a different group of circling birds. The total number of such glides from all the groups was about five per minute. When gliding, the upper bird (a male?) kept its wings bent down and the lower bird (a female?) kept its wings arched up, so that the wing tips of the two birds were about three inches apart. No physical contact was noted. Occasionally a third bird would interfere with the gliding pair and cause them to separate. No organization within the circling groups could be detected, and no preliminary indication of which two birds would suddenly depart from the flock was noted. Occasionally, however, it seemed that the lower bird of the two would start out slightly before it was joined by the upper one. At 3:12 p.m. the flock began to disperse, but some pairs were still gliding down. By 3:20 only 16 birds were left, and by 3:50 all except three were gone. The total duration of this behavior pattern was about one hour.

Three tropic birds were seen at Socorro in mid-morning on March 17. Two began calling and gliding as described above, and the third attempted to interfere. On March 18, in mid-afternoon, two Tropic Birds were seen at sea on the north side of Socorro. They were flying one above the other, keeping one or two feet apart at all times. They flew in a zig-zag pattern, simultaneously changing direction about every 5 to 10 wing beats. At times the lower bird seemed to be a fraction of a second behind the upper in changing direction. No gliding was observed, and the zig-zag flight continued on out of sight.

No tropic birds were seen at Clarión. Some were seen at San Benedicto on November 17, including one bird on a nest with one egg. Tropic birds were less numerous in November than they were in March, and no gliding behavior was observed in November.

†*Pelecanus occidentalis californicus*. Brown Pelican. One was seen at San Benedicto on March 9.

Sula nebouxii. Blue-footed Booby. Several were seen on San Benedicto on November 17.

Sula dactylatra californica. Blue-faced Booby. About 20 were seen on or near Roca Partida on March 8. At San Benedicto, in March, they were often seen flying about the Ash Heap and then going to their roosting sites on the north end of the island. Twenty miles southeast of San Benedicto one flew past the boat at 11:00 p.m. on March 20. On November 17, many had begun to roost on eroded areas or new ash in nonwindy places on top of San Benedicto island. The largest of these groups consisted of about 500 birds. Many fledglings and immature birds were present here in November. Several adults were seen at the north end of Socorro on March 17 and November 20.

These boobies were common on Clarión, especially on the south and east sides of the island. Groups of 18 to 20 birds, paired and unpaired, were found sitting in low grass; the pairs were 20 to 30 feet apart, and each group was approximately 100 yards from the next one. The total population of Blue-faced Boobies on Clarión in March was estimated at 150 birds. At midday on March 25, a pair of these boobies was observed in copulation on the ground in the shade of a *Euphorbia* bush. Two pairs were sitting on eggs at this date.

Sula sula websteri. Red-footed Booby. Birds in brown plumage were noted about 50 miles east-northeast of Roca Partida on March 22, and at San Benedicto on November 9, 12, and 17. Birds in white plumage were seen only at Clarión, where they greatly outnumbered the brown ones.

In March, three major areas were found on Clarión where Red-footed Boobies were nesting. One group of about 30 birds was situated on the north side of the island, about one and one-half miles northeast of Mount Gallegos, and the other two groups were noted on the lower slope of the southeast side of the peak. The latter two were about one-half mile apart and consisted of about 50 and 70 birds, respectively. The total population was at least 150 individuals, possibly as many as 200.

The nests consisted of loose platforms of sticks placed about three feet above the ground in thick bushes. These were usually two to four feet apart, but some were as much as 20 feet away from others. About 20 per cent of the birds in the largest rookery were in brown plumage, and none of these had nests; they roosted in bare bushes. The other 80 per cent were in predominately white plumage, in which the amount of brown, black, and white varied considerably. About half of these birds were nesting, but not all of the nests yet contained the single bluish-white egg characteristic of this species. Empty nests were used for roosting. Some courtship and aggressiveness by males was noted, and occasionally a male would interfere with a courting pair on a neighboring nest.

Bill colors of brown-plumaged birds were highly variable. In some the bill was blue or brownish at the base and pink at the tip; in others it was all brownish or all blue.

Sula leucogaster brewsteri. White-bellied Booby. About 10 were seen at Roca Partida on March 8, and some of these were nesting. On San Benedicto, this species comprised about 5 per cent of the total booby population. Two nests, each with one egg, were found on San Benedicto on November 17, and indviduals were seen there on March 9 and 28. White-bellied Boobies were also seen off the north side of Socorro on November 19 and 20.

Fregata minor palmerstoni. Lesser Frigate Bird. No more than 10 were seen about San Benedicto in March as most of their roosting places had been covered with pumice by the volcanic eruption of 1952, but large numbers were observed there on November 17. At that date there were two nesting colonies of about 36 and 80 birds each, and the total population was estimated at 150 to 200 birds.

In the 36-bird colony, the nests consisted of sticks and green plant matter from newly sprouted plants and were placed on the ground from two to six feet apart. Most of the nests contained one egg or one pin-feathered young. Birds with empty nests were carrying on courtship on the nest itself. One male was seen putting his head and neck around that of the female and then calling loudly and snapping his bill quickly; the female would then bite him on the neck or bill. In males, the bill was blue-black and the orbital ring black; in females, the bill was largely pink and the orbital ring red. Foot color was not recorded.

Frigate birds were seen on March 17 and 18 at the north end of Socorro, and on November 19 and 20 they were seen in the same area as well as elsewhere around the island. A group of four was seen during most of the latter day above a small cove at the north end of Socorro. Occasionally one would dive down and pick up a fish from the surface of the water; then the others would chase the one with the fish. Several were seen at Clarión in March; this island was not visited in November.

Leucophoyx thula. Snowy Egret. Four were seen at Clarión, on the beach at Sulphur Bay on March 23 and 24. They remained in the vicinity of the bay and were observed many times.

Nyctanassa violacea gravirostris. Yellow-crowned Night Heron. One was seen on March 16 on Socorro, standing on lava rocks just north of Binner's Cove.

Plegadis falcinellus mexicana. Glossy Ibis. Four were seen on March 23 and 24 with the four Snowy Egrets at Sulphur Bay on Clarión. Like the egrets, they stayed in the vicinity of the cove and were seen many times.

Buteo jamaicensis socorroensis. Red-tailed Hawk. This species was seen regularly at Socorro in both March and November, and the birds seemed to be more abundant at the higher elevations of the island. Possibly these hawks often feed on lizards, for the lizards of Socorro are much warier than the related species on Clarión, where no hawks are resident.

One Red-tailed Hawk seen soaring over San Benedicto (†) on November 17 was presumably of the Socorro race.

**Pandion haliaëtus carolinensis.* Osprey. One was seen at the east side of San Benedicto on November 17, and another, or possibly the same bird, was seen at Socorro on November 19.

**Falco peregrinus*. Peregrine Falcon. One was seen around Binner's Cove at Socorro on November 18.

Numenius phaeopus hudsonicus. Hudsonian Curlew. One was seen on the lava rocks north of Binner's Cove, Socorro, on March 15, and one was seen on top of the north end of San Benedicto (†) on November 17.

Actitis macularia. Spotted Sandpiper. Several were seen at Binner's Cove and at Henslow Point, Socorro, in March. One was collected by G. Dallas Hanna at the north end of Socorro on November 20. Several were seen at Sulphur Bay on Clarión in March.

**Ereunetes mauri*. Western Sandpiper. **Erolia minutilla*. Least Sandpiper. A flock of six birds of these two species was seen at Sulphur Bay, Clarión, on March 24. One of each species was collected, but the specimens were badly crushed in the ship's freezer and could not be preserved as skins or skeletons.

Himantopus mexicanus. Black-necked Stilt. Two were seen on the sandy beach at the east end of Sulphur Bay at Clarión on March 25.

Zenaidura macroura clarionensis. Mourning Dove. This species was not especially common on Clarión in March. It tends to prefer areas of rock covered by morning-glory (*Ipomea*). A few doves were seen on March 26 on Monument Peak, a barren lava and sedimentary pinnacle about 50 yards off the northwest tip of Clarión. Two males in good plumage taken on March 23 each had enlarged testes measuring 15 mm. in greatest diameter.

Zenaidura graysoni. Socorro Dove. This species was common around the lava rocks at low elevations on Socorro in March, but in November it was rare in such places and common above 1500 feet. At the higher elevations, the doves were usually found under fig trees (*Ficus*).

Columbigallina passerina socorroensis. Ground Dove. These doves were found primarily in areas of tall bunch grass or shrubs (*Croton masoni*) below 1000 feet on Socorro. Some were seen in a small cave in a cliff only 20 yards from the ocean, and in March one was seen on a rock at the ocean's edge apparently drinking sea water. The bird went through the motions of drinking, but there was no way of telling how much, if any, sea water was swallowed. Ground Doves were not common anywhere on the island, and they were quite wary although many other resident birds were very tame. In November they seemed more numerous than in March, especially about the north side of the island. On November 19, a juvenal Ground Dove barely able to fly was found near Binner's Cove, and a dead juvenile of about the same age was found nearby on the same day. One male with enlarged testes measuring 8 × 5 mm. was collected on March 16.

Aratinga holochroa brevipes. Green Parakeet. These noisy birds were common on Socorro in all forested areas, that is, in the higher parts of the island and in the forested canyons on the north side that extend down to the coast. They were very tame and were easily approached. On November 19, three males and two females were collected. None had enlarged gonads, and all were in fresh plumage with pin-feathers still present among the body feathers. One male had a single orange feather on the right side of the neck.

Speotyto cunicularia rostrata. Burrowing Owl. This species was common everywhere on Clarión. The owls were seen near the entrances to their burrows in the morning until about 10:00 a.m.; after that they withdrew and did not reappear until the late afternoon. Several Burrowing Owl pellets were examined, and all contained cricket remains and seeds of the prickly pear cactus that was in fruit in March. One pellet contained unidentified bird feathers. Cricket remains were found at the entrances of most of the burrows. These owls were quite tame, and with caution they could be approached to within two feet. Two males were collected on March 23. The testes of one were slightly enlarged and measured 8 × 5 mm.

†*Ceryle alcyon*. Belted Kingfisher. One was seen several times on March 18 flying over a small cove behind Henslow Point on the northwest side of Socorro.

†*Hirundo rustica erythrogaster*. Barn Swallow. About 20 were seen flying about or sitting on the pumice at the north end of San Benedicto on November 17. One of these, a male, was collected; it was slightly fat.

Corvus corax clarionensis. Raven. This species was noted only on the south and west sides of Clarión, and it was most numerous about Mount Gallegos. Many Ravens were molting their primaries in March. Although not especially wary, they flew if one approached closer than 10 or 20 feet. Flocks

of 52, 66, and 120 were seen in flight at various times, and a count of 320 Ravens in flight was made from the top of Mount Gallegos, from which the whole island could be seen. The total population in March was estimated at 400 to 450 birds. No Ravens were seen on San Benedicto in 1953.

Behavior which may have been courtship or aggressiveness was observed in March. Of a group of 15 birds on the ground, two would jump about two or three feet in the air while facing each other, hover momentarily, and sometimes claw at each other with their feet. This clawing was not very vigorous, and the performance did not seem to be strongly aggressive. After one "jump-up," one of the two birds would often chase the other out of the area where the group was gathered. Then both birds would jump up and down with wings half spread, but not necessarily facing each other as in the original encounter. Often one or both birds later returned to the group. Usually only one encounter took place at a time, and the other members of the group paid little or no attention to the participants. Raven droppings on Mount Gallegos contained seeds of cactus and those of a different but unidentified plant. No animal matter was recognized.

Thryomanes sissonii. Socorro Wren. This wren was fairly common in most habitats on Socorro, but it was most numerous in the non-forested portions below 2000 feet. It seemed to be unafraid of man. In March no territorial behavior or singing was noted, but in November the wrens sang often. A male in worn plumage was collected on March 16; the testes were not enlarged.

Troglodytes tanneri. Clarión Wren. This species was common on Clarión in March but was found principally among the vine-covered shrubs that occur over much of the island. In this respect, it differs from the Socorro Wren, found on Clarión, which is common in all habitats—in shrubs or grass, on rocks or bare ground. Clarión Wrens were often heard singing in March, and some territorial defense by threat was noted. The size of the territory seemed to vary with the density of the shrubs in which the bird was located. In the denser areas, the territories appeared to be 30 or 40 feet in diameter. Defense by threat consisted of screeching and wing-fluttering without any physical contact.

A female in worn plumage, collected on March 23, had follicles enlarged up to 1.5 mm. in diameter.

The large size of this wren as compared with mainland forms of *Troglodytes* seems to be correlated with larger egg size. Ed N. Harrison of Los Angeles has kindly allowed us to measure a set of three eggs of *T. tanneri*, taken on March 25, 1938, from his collection. The measurements (in mm.) are as follows: 19 x 24, 19.5 x 14, and 21 x 14 (av. 19.8 x 14). The average size of 40 sets of *T. aëdon parkmanii* as given by Bent (1948) is 16.3 x 12.6. The averages of the eggs of *tanneri* are thus 21.4 per cent longer and 11.1 per cent wider than those for *T. a. parkmanii*. In color, eggs of *tanneri* are similar to those of *parkmanii* but have sparser and more distinct (less blended) spotting which is more concentrated around the large end of the egg.

Chapman and Griscom (1924:284–285) called attention to the close resemblance between *Thryomanes sissonii* and some members of the genus *Troglodytes*, including *tanneri*. To this we might add that *T. tanneri* has certain characters (large size, relatively large bill, hallux much longer than outer toe) that resemble those of the genus *Thryothorus*; it lacks, however, the subterminal notch to the culmen characteristic of that genus. Field studies of the songs and behavior of both the Socorro and Clarión wrens are necessary to clarify their relationships.

Salpinctes obsoletus exsul. Rock Wren. As mentioned above, this endemic form could not be found anywhere on San Benedicto and is presumably extinct.

Mimodes graysoni. Socorro Thrasher. Thrashers were common at lower elevations on Socorro in March, and at that time they seemed to prefer open areas with a few shrubs. No singing or territorial behavior was noted. In November, thrashers appeared to be rare at lower elevations on the south side of Socorro but common in forested areas at higher elevations and in canyons on the north side of the island. Some aggressive behavior and much singing were noted at this season. A three-note whistled call was heard most often; it may be diagrammed as "– – –." A more extended and varied song was heard less often. It consisted of rambling warbled phrases of a variable nature, but frequently the same phrase was repeated several times in the manner of other members of the Mimidae. However, no mimicry of any kind was recognized. The birds were very tame and seemed reluctant to fly. They moved about by hopping, and none was seen to fly farther than 10 feet.

In March, several thrashers were seen on successive days around sheep carcasses, where they fed on blow flies congregated there. There was some aggressiveness during feeding, and only one bird at a time fed close to the carcass on each side. Flies were caught only when they alighted and not while in flight.

Two males were collected on March 14. One had testes measuring 3 x 1 mm. and was moderately fat; the other had testes measuring 4 x 2 mm. and was extremely fat. One female was collected in March; the follicles were not noticeably enlarged and the bird was not fat. The rectrices of all three birds were very worn, and the female had two half-grown new tail feathers. The remiges and body feathers were moderately worn.

Parula pitiayumi graysoni. Tropical Parula Warbler. These little warblers were fairly common at lower elevations on Socorro, but they seemed scarcer than the other endemic land birds although equally tame and easy to approach. They were most abundant in bushes and low trees four to five feet above ground, although they were often seen hopping across piles of lava. No singing or territorial behavior was noted in either March or November. One unsexed bird was collected on March 14; it was slightly fat.

**Dendroica castanea.* Bay-breasted Warbler. One of these warblers was found in a weakened condition on San Benedicto on November 18; it was captured alive and later prepared as a specimen for the Dickey Collection. The bird is an immature male with a few black feathers on the anterior part of the crown and a few bay feathers along the flanks.

Pipilo erythrophthalmus socorroensis. Red-eyed Towhee. Towhees were common on Socorro in the cactus and brush of the lower elevations but were rare among the trees. Like the Socorro Thrashers, they were tame and reluctant to fly; no flights of more than 10 feet were seen. No territorial behavior or song was noted in either March or November. In March, an adult was seen feeding a begging immature bird. Carl L. Hubbs has informed us (personal communication) that on Socorro on August 26, 1946, he heard towhees singing and discovered a nest of these birds in a shrub near the coast. The eggs were bluish gray with indistinct dark markings, as in other members of this species.

Two males were taken on March 14 in unworn plumage and were moderately fat; the testes were not enlarged. A female taken on March 16 in very worn plumage was not fat and did not have enlarged follicles. The iris was red.

DISCUSSION

The great potential mobility of birds and the strong element of chance involved in reaching remote islands usually makes it difficult to determine with any precision the area or population from which insular forms are derived. It is always of interest, however, to explore the possible origins of the avifauna of an oceanic archipelago.

Of the 25 species of birds known to breed on one or another of the Revilla Gigedo Islands, 10 are sea birds of the orders Procellariiformes, Pelecaniformes, and Charadriiformes. Only one form of sea bird, *Puffinus auricularis,* is endemic to the islands, and this species is a representative of a cosmopolitan genus. It may have been derived from the similar and wide-ranging *Puffinus puffinus.* All the other breeding sea birds are widely distributed species, and those of the Revilla Gigedo Islands have not differentiated from other populations.

It is surprising that no storm petrels (Hydrobatidae) breed in the archipelago; *Oceanodroma leucorhoa socorroensis* is misnamed, for it breeds on Guadalupe Island and only strays to the vicinity of Socorro.

The other 15 resident species are all land birds, including the Yellow-crowned Night Heron of Socorro. This relatively short-legged race is largely terrestrial in its habits, and it is found on the drier parts of the island as well as on the beaches. Of these 15 species, all but one are endemic forms of varying degrees of differentiation. The single exception, *Corvus corax clarionesis,* was described from Clarión as an endemic race, but the characters ascribed to it are found in other populations and the subspecies, if valid, is therefore not endemic to the Revilla Gigedo group. All the other land birds are well-marked forms, including the monotypic genus *Mimodes* and the distinct species *Zenaidura graysoni.* Whether or not the wrens *Thryomanes sissonii* and *Troglodytes tanneri* should be considered full species can be clarified only by careful study of their habits; in any case, they are morphologically distinct.

The ancestry of *Mimodes* is uncertain. Young specimens of *M. graysoni* are more

rufous, more heavily spotted on the under parts, and elsewhere more distinctly marked than are adults. In color pattern these immatures appear quite similar to certain species of *Toxostoma* such as *T. cinereum* of Baja California, but the resemblance may be no more than superficial. *Mimodes* has a subterminal notch on the culmen that is lacking in *Toxostoma* but present in several other mimid genera. Whatever its derivation, *Mimodes* is a well differentiated form whose progenitors cannot be identified or located with any confidence.

Aratinga holochroa brevipes and *Parula pitiayumi graysoni* are representatives of primarily neotropical species which, however, range both north and south of the Revilla Gigedo Islands. All the other land birds, including *Zenaidura graysoni*, are derived from primarily nearctic types that are found also both north and south of the latitude of the islands. Thus, although most of the land birds of the archipelago have a distinctly nearctic aspect, they may have been derived from populations on the mainland at low latitudes. It is also entirely possible that the resident parakeet and warbler populations came from mainland areas considerably north of the islands.

Johnston (1931) found that the great majority of the terrestrial plant species found in the Revilla Gigedo Archipelago show closest affinities with those of Baja California and northern México. The few species of reptiles found on the islands appear to be derived from closely related forms of the Sonora-Sinaloa area (Brattstrom, 1953, and manuscript). These data suggest that wind and currents are more likely to bring organisms to the archipelago from areas to the north of it than from the south, and the composition of the bird fauna does not conflict with this supposition.

It is interesting that no species of land bird is resident on more than one island, even though some species at least might be expected to find a satisfactory environment and little or no competition on an island other than their home. Possibly the original colonizers in each case were few in number, for then the chances of their reaching more than one of the widely-spaced islands would have been slight. The varying degrees of differentiation of the endemic forms suggest that the islands were reached at several different times rather than in one or even two waves. It is likely that the Mourning Dove first reached Socorro, evolving into *Zenaidura graysoni*, and that a much later contingent from the mainland colonized Clarión and differentiated into *Zenaidura macroura clarionensis*. The ancestors of the distinct *Mimodes graysoni* may have reached Socorro even earlier than those of the Socorro Dove, and those of the other passerines probably came later.

The geological age of the islands is not presently known, but the age sequence from oldest to youngest is believed to be Clarión, Roca Partida, Socorro, and San Benedicto (Adrian Richards, personal communication). It is possible that not all the islands were present or habitable at the time the first land birds arrived; if so, several colonizations must undoubtedly have occurred.

Although the places of origin of the endemic birds cannot be narrowed down to a small area, it is noteworthy that the avifauna of the archipelago is not merely a random sample of that of the nearest mainland. The scarcity or absence of fresh water on the islands is certainly an important factor in limiting the variety of resident land birds, and most of the insular forms are representatives of species with a wide range in many habitats. These birds are presumably able to survive and establish themselves in harsh environments. The Elf Owl, *Micrathene whitneyi graysoni*, might be considered an exception, but little is known of its habits and distribution outside of the United States, and it may be more widespread and successful than is now supposed. On the other hand, it is somewhat surprising that the House Finch, *Carpodacus mexicanus*, which has successfully colonized other islands off the Mexican coast, has never become established in the Revilla Gigedo group.

The future of the avifauna of the islands appears to be secure at present. There are no human inhabitants, and no mammals of any kind except the moderate and apparently stable population of sheep on Socorro. Few ships stop at any of the Revilla Gigedo Islands, and the birds are seldom molested. The remote location and generally barren aspect of the archipelago have so far protected its biota from all except volcanic destruction. While this fortunate condition still exists, it may be hoped that the Mexican government will guard against the introduction of mammals such as rabbits, cats, goats and others that have invariably brought disaster to the flora and fauna of insular regions.

CHECK-LIST OF THE BIRDS OF THE REVILLA GIGEDO ISLANDS

The following check-list has been compiled as a convenience for future visitors to the archipelago. Only those sea birds which breed or roost on the islands or which have been found immediately offshore are included. Sea birds breeding on one or another of the islands are presumed to occur in the vicinity of the others, and only the islands where actual nesting takes place are listed for such species. Species for which there is one record are listed as accidental; species recorded twice to several times are listed as casual. Many birds in these two categories probably occur much more regularly than the few records indicate. Sight records only are indicated by a double dagger (‡).

In several instances, the status of a species has been found to differ from that given by Friedmann, Griscom, and Moore (1950). We wish to thank H. Friedmann and L. Griscom for their kind assistance in determining the changes to be made.

Puffinus pacificus chlororhynchus. Wedge-tailed Shearwater. Breeds on San Benedicto.

Puffinus auricularis. Revilla Gigedo Shearwater. Breeds on Clarión, San Benedicto, and possibly Socorro.

Oceanodroma leucorhoa socorroensis. Leach Petrel. Casual to regular visitor to all islands.

Phaëthon aethereus mesonauta. Red-billed Tropic Bird. Breeds on San Benedicto.

Pelecanus occidentalis californicus. Brown Pelican. Accidental on Socorro and San Benedicto (‡).

Sula nebouxii. Blue-footed Booby. Breeds on San Benedicto and possibly Roca Partida.

Sula dactylatra californica. Blue-faced Booby. Breeds on Clarión and San Benedicto.

Sula sula websteri. Red-footed Booby. Breeds on Clarión and San Benedicto.

Sula leucogaster brewsteri. Brown Booby. Breeds on San Benedicto and Roca Partida.

[*Phalacrocorax auritus albociliatus*. Double-crested Cormorant. We are unable to find an unquestionable record for this species although virtually all check-lists and reference works include the Revilla Gigedo Islands within its range. The original basis for inclusion seems to be the statements of Ridgway (1883, 1884) that this cormorant is found in the "Revillegigedo [sic] Islands" and (1887) Socorro Island specifically, but no definite sight records or specimens are mentioned. We feel that Ridgway must have been in error, for at the time of his writing no biologist had visited the islands since Grayson in 1867; the next observations and collections there were those of Townsend in 1889. Neither Grayson (1871) nor Lawrence (1871, reporting on Grayson's specimens) nor Townsend (1890) nor any subsequent visitor has recorded this or any other cormorant from Socorro or any other island of the Revilla Gigedo group. Thus, unless a specimen is found to substantiate Ridgway's citation, the Revilla Gigedo Islands should be excluded from the range of this species.]

Fregata minor palmerstoni. Lesser Frigate Bird. Breeds on San Benedicto and Carión.

‡*Ardea herodias*. Great Blue Heron. Regular visitor to Clarión and Socorro.

‡*Leucophoyx thula*. Snowy Egret. Casual on Clarión.

Nyctanassa violacea gravirostris. Yellow-crowned Night Heron. Breeds on Socorro.

‡*Plegadis falcinellus mexicana*. Glossy Ibis. Casual on Clarión.

‡*Anas discolor*. Blue-winged Teal. Accidental on Clarión.

Buteo jamaicensis socorroensis. Red-tailed Hawk. Breeds on Socorro, casual on San Benedicto (‡). A sight record for *B. j. calurus* on Socorro (Kaeding, 1905) is not considered reliable.

‡*Pandion haliaëtus carolinensis*. Osprey. Accidental on San Benedicto and Socorro.

‡*Falco peregrinus*. Peregrine Falcon. Accidental on Socorro.

[*Haematopus ostralegus frazari*. Oystercatcher. The inclusion of the Revilla Gigedo Islands within the range of this species in the *Distributional Check-list of the Birds of Mexico* is based on a mistaken reading of the paper by McLellan (1926) entitled "Expedition to the Revillagigedo Islands, Mexico, in 1925, VI. The Birds and Mammals." This paper includes records of the Oystercatcher from several other islands off the Pacific coast of México but not from the Revilla Gigedo group, and this archipelago should therefore be excluded from the range of the species.]

Pluvialis dominica fulva. Golden Plover. Accidental on Clarión. Several other records from Clarión are of undetermined subspecies.

‡*Charadrius hiaticula semipalmatus*. Semipalmated Plover. Accidental on Socorro.

Numenius phaeopus hudsonicus. Hudsonian Curlew. Casual on Clarión, Socorro (‡), and San Benedicto (‡).

Actitis macularia. Spotted Sandpiper. Regular visitor on Socorro and Clarión.

Catoptrophorus semipalmatus inornatus. Willet. Accidental on Socorro.

Heteroscelus incanus. Wandering Tattler. Regular visitor on Socorro, Clarión, and San Benedicto.

Arenaria interpres interpres. Ruddy Turnstone. Regular visitor on Clarión.

Crocethia alba. Sanderling. Accidental on Socorro.

Ereunetes mauri. Western Sandpiper. Accidental on Clarión.

Erolia minutilla. Least Sandpiper. Accidental on Clarión.

Himantopus mexicanus. Black-necked Stilt. Casual on Clarión.

[*Larus heermanni*. Heerman Gull. Mistakenly listed in the *Distributional Check-List of the Birds of Mexico* on the basis of records from Isabel Island off the coast of Nayarit. This island is not part of the Revilla Gigedo group and this species should therefore be dropped from the list of Revilla Gigedo birds (see Oystercatcher).]

‡*Larus occidentalis*. Western Gull. Casual on Clarión.

Sterna fuscata crissalis. Sooty Tern. Breeds on Roca Partida and Oneal Rock, Socorro.

Anoüs stolidus ridgwayi. Brown Noddy. Breeds on Roca Partida and Oneal Rock, Socorro.

Gygis alba. White Tern. Gifford (1913) stated that R. H. Beck took a single specimen of this tern, the only one seen, on Oneal Rock at Socorro on July 27, 1905. Almost all reference works since then have included the Revilla Gigedo Islands within the range of this species, and Friedmann, Griscom, and Moore (1950) reported a colony of White Terns on Oneal Rock. A search of the literature, however, fails to reveal a single record from the Revilla Gigedo Islands other than the original specimen mentioned by Gifford. No landings were made on Oneal Rock in 1953, but the boat passed within 100 yards of it many times in both March and November and no terns of any kind were seen. Mr. Gifford has kindly checked his field notes for the 1905 expedition and informs us that his statement that only one White Tern was found at Oneal Rock is correct. Thus, unless we have overlooked a subsequent record, the White Tern should be considered only an accidental visitor to the Revilla Gigedo Archipelago.

Zenaidura macroura clarionensis. Mourning Dove. Breeds on Clarión.

Zenaidura graysoni. Socorro Dove. Breeds on Socorro.

Columbigallina passerina socorroensis. Ground Dove. Breeds on Socorro.

Aratinga holochroa brevipes. Green Parakeet. Breeds on Socorro.

Micrathene whitneyi graysoni. Elf Owl. Breeds on Socorro.

Speotyto cunicularia rostrata. Burrowing Owl. Breeds on Clarión.

Asio flammeus flammeus. Short-eared Owl. Accidental on Clarión.

‡*Ceryle alcyon*. Belted Kingfisher. Accidental on Socorro and Clarión.

Hirundo rustica erythrogaster. Barn Swallow. Casual on Clarión; accidental on San Benedicto.

Corvus corax clarionensis. Raven. Breeds on Clarión; regular visitor on San Benedicto.

Thryomanes sissonii. Socorro Wren. Breeds on Socorro.

Troglodytes tanneri. Clarion Wren. Breeds on Clarión.

Salpinctes obsoletus exsul. Rock Wren. Formerly bred on San Benedicto; apparently exterminated in 1952.

‡*Mimus polyglottos*. Mockingbird. Accidental on Clarión.

Mimodes graysoni. Socorro Thrasher. Breeds on Socorro.

Anthus spinoletta pacificus. Water Pipit. Accidental on Socorro.

Parula pitiayumi graysoni. Tropical Parula Warbler. Breeds on Socorro.

Dendroica castanea. Bay-breasted Warbler. Accidental on San Benedicto.
‡*Molothrus ater*. Cowbird. Accidental on Clarión.
Pipilo erythrophthalmus socorroensis. Red-eyed Towhee. Breeds on Socorro.

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Department of Zoology, University of California, Los Angeles, August 18, 1955.

PTERLYOGRAPHY AND MOLT OF THE ALLEN HUMMINGBIRD

By ELMER C. ALDRICH

Knowledge concerning pterylography of any avian species is a necessary part of an effort to study its plumages and molts. The increasing attention given matters of aging according to plumage criteria and to the phenomenon of sexual dimorphism also calls for precise background information concerning pterylography. Furthermore, this aspect of external morphology continues to serve in examinations of phylogenetic relationships.

Among hummingbirds, there is information on pterylography available for only one species, the Giant Hummingbird (*Patagona gigas*) of South America, provided by Thompson (1901). Certain critical details were, however, not considered by Thompson, and in any event the size and diversity of the family Trochilidae is such that a number of species representing different sections of the family must be examined to ascertain the basic features of feather-tract patterns among its members. It is therefore the objective of this paper to describe the pterylography of the Allen Hummingbird (*Selasphorus sasin*), a species occurring primarily in coastal California but representing a genus with eight members distributed over western North America and southward to Panamá. Certain facts concerning molt are also reported, but these must be regarded as only preliminary results because the series of specimens available at the time of the study was relatively small and not representative of all seasons.

ACKNOWLEDGEMENTS

The studies reported here were carried out in 1937–38 under the direction of the late Joseph Grinnell as part of a thesis investigation (Aldrich, 1939). A portion of the thesis concerned with nesting of the Allen Hummingbird has already been published (Aldrich, 1945). That this additional part is now prepared for publication is largely due to the interest and assistance of Dr. Frank A. Pitelka and Mr. Francis S. L. Williamson, to whom I express my appreciation. For assistance in the preparation of the drawings, I am indebted to Mrs. Alice Aldrich Labellarte.

MATERIALS AND METHODS

Specimens of three males and two females used for the study of pterylography were taken in the San Francisco Bay region between the dates of March 4 and May 25, 1938. Drawings were made from these birds after their feathers were clipped and while the birds were fresh. Feathers were cut near their bases, usually one at a time, and never more than about three at one clipping. All feathers were segregated according to tracts and placed in labelled envelopes so that the total number of feathers for each specimen examined might be obtained. Clipped birds were kept moist with wet cotton to facilitate mapping of the feathered areas. The larger feathers of the wing, the primaries, secondaries and their greater coverts, were not clipped, but the webs were sheared from the shafts. This procedure was essential to retain, for drawing, the angles of insertions of the feather bases in the skin.

The most intensive work was done on female specimens. This was rechecked with study of three males, and differences between sexes were noted. Most of the differences in shapes of tracts were a result of the differences between sexes in size and proportions. Drawings and descriptions are based on females. However, where differences occur in the the extent of a tract or in types of feathers within that tract these are mentioned in the remarks on the tract in question.

The nomenclature here used for the regions of the tracts (figs. 1 and 2) is essentially that employed by Boulton (1927) and Miller (1931). No effort is made to provide a

detailed textual description; rather the objective is to present drawings with text serving as a supplement that will stress certain general features and provide comment on relevant published work.

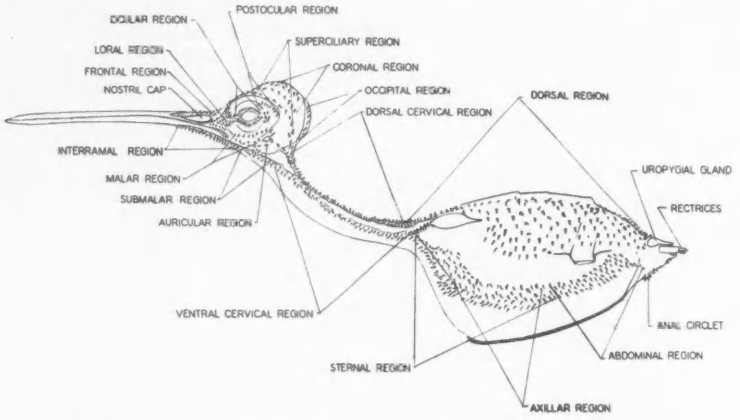

Fig. 1. Pterylography of *Selasphorus sasin*, lateral view, approximately $\times 2$.

Capital tract.—The frontal region extends from the base of the bill above and anterior to the cap covering the nostril posteriorly to an imaginary line running between the middle of the orbits (figs. 1 and 2). Laterally the frontal region is separated from the loral region anteriorly, and from the supercilliary region more posteriorly, by the superciliary apterium, which begins at the base of the nostril cap, courses posteromedially to the dorsal border of the orbit, and extends to the posterior end of the coronal region. The frontal region encloses the frontal apterium, a narrow space 6 mm. long and 1 mm. wide. This apterium occupies a longitudinal depression between the dorsal borders of the orbits.

Thompson (1901) finds a similar frontal apterium in the Giant Hummingbird (*Patagona gigas*). He notes, however, that in this species the space continues forward to the culmen, whereas in the Allen Hummingbird, there is a 3-mm. feathered interval between the apterium and the base of the exposed culmen. In other respects it is quite similar. Nitzsch (1867:87) failed to note this apterium in *Trochilus moschitus*. Shufeldt (1890), however, states, "This [apterium] is well marked in all species [of hummingbirds] which I have thus far examined, moreover, it is absent in the Swifts and Swallows." Other birds found to have the median frontal apterium seem to be in closely related orders as well as in groups farther distant. Thompson (1901:315) found it in *Caprimulgus macrurus*, and he refers to Clark's (1894) account of it in *Phalaenoptilus nuttallii*, both members of the Caprimulgiformes, an order closely related to hummingbirds. Miller (1931) describes the frontal apterium of the Loggerhead Shrike (*Lanius ludovicianus*) and attributes its presence to the elevation of the maxillaries and nasals into a median crest coincident with the production of a raptorial bill. Burt (1929:433) describes in detail the frontal apterium of woodpeckers and correlates this space with the extension of the hyoid apparatus which perhaps causes pressure on the skin beneath, not permitting feathers to grow. This seems a reasonable correlation in woodpeckers as he found the frontal apterium of *Ceophloeus pileatus* asymmetrically placed and deviating to the right, immediately above the extended hyoid.

The occurrence of the frontal apterium in the Allen Hummingbird is difficult to link with any of these associated structural arrangements even though the hyoid processes are long as in woodpeckers. The ends of the ceratobranchial bones extend into the frontal apterium a relatively short distance (about 1 mm.). Burt found a similar situation in *Sphyrapicus* where the apterium was present beyond

the termination of the hyoids, and he attributes this condition to an evolutionary reduction in the length of the hyoids. The only place in the Allen Hummingbird where feathers occur in the skin overlying the ceratobranchials is just posterior to the frontal apterium where there is a band of feathers about 2 mm. wide; such overlap is not found in *Sphyrapicus*. Posterior to this band of coronal feathers, those of the occipital region seem to lie in rows parallel with the ceratobranchials over the skull. The frontal apterium, since it occupies a depression, is easily covered in the adult bird by surrounding feathers. The skin of the frontal apterium is thin and closely adherent to the skull.

Nearly all the feathers of the occipital, coronal, and frontal regions possess the same general color and structural pattern. Exceptions to this are the dense, short anterolateral feathers of the frontal region in the adult male which are similar to the orange feathers of the loral region in color and structure. The feathers of the frontal region are placed in no apparent order whereas those of the occipital and coronal regions are in single rows with the feathers less dense than are those of the frontal region.

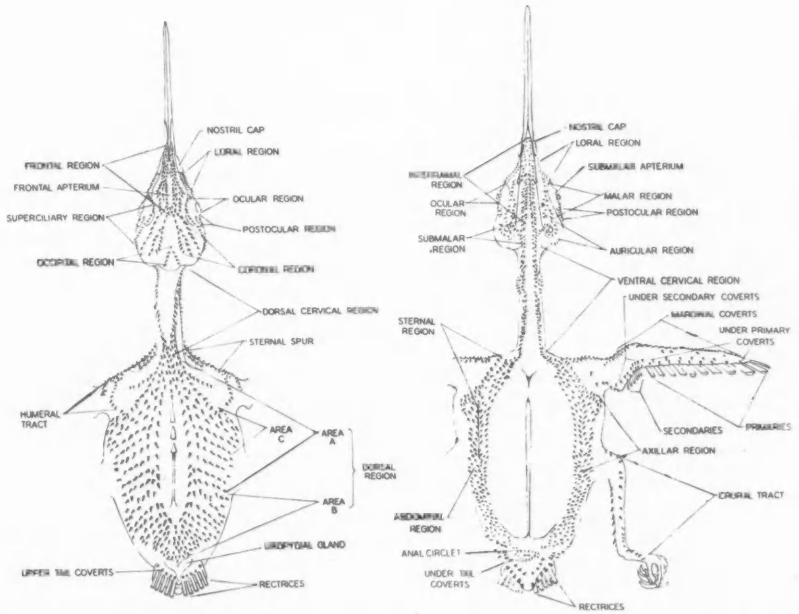

Fig. 2. Pterylography of *Selasphorus sasin*, dorsal view at left, ventral view at right; approximately ×2.

The feathers of the posterior part of the head possess a relatively larger downy basal portion than do those anteriorly. The short feathers above the nostril have a downy portion less than one-tenth the total feather length, whereas those of the occipital and coronal regions may be one-half downy. On some feathers there was an aftershaft, consisting of three or four filaments branching distally, which was one-half the length of the main shaft. These appeared to be essentially the same morphologically as the downy portion of the feather proper.

Spinal tract.—To simplify description, this tract will be subdivided into two regions only (cervical and dorsal) instead of the customary four (cervical, interscapular, dorsal, and pelvic). The cervical region is essentially a single row of feathers connecting the auricular and superciliary regions posteriorly with the dorsal tract. On the neck proper, they are inserted on a longitudinal fold in the

skin that occupies a dorsal position on each side of the neck. Anteriorly near the base of the skull the dorsal and ventral cervical regions come close together and fuse. This is one of the two places in the Allen Hummingbird where the dorsal and ventral tracts meet, the other place being at the fusion of the malar and submalar regions below the ear.

The dorsal region is a large area of feathers that are inserted on the back from the shoulders to the base of the tail (area A). This region spreads laterally behind the wings (areas B and C) and nearly merges with the posterior tip of the abdominal region of the ventral tract; but at that point it remains distinct because of the white, downy character of the feathers of the latter tract. The dorsal region encloses the dorsal apterium, which extends anteriorly between the wing bases and posteriorly to a bony knob of the synsacrum. The apterium is about 2½ mm. wide, tapering at both ends, and about 17 mm. long. A similar apterium occurs in many kinds of birds in widely separated orders, and it is of no ordinal significance. In the Allen Hummingbird, however, the presence of this apterium may be correlated with the presence of hard, bony structures immediately below the skin. Three of the vertebrae anterior to the synsacrum form a hard and sharp ridge. There is a similar but unjointed ridge extending back from them, ending in a rounded point over the center of the synsacrum.

Ventral tract.—In the interramal region, the feathers display a marked sexual dimorphism, as is true of most hummingbirds, since these are the feathers forming the gorget of the adult male. In the adult male of *Selasphorus sasin,* the iridescent gorget feathers are smallest anteriorly where they may be 0.5 mm. in length; the longest, reaching 12.5 mm., occur posteriorly and laterally, in the "tails" of the gorget on the sides of the neck.

All the gorget feathers of the male have the same color and structural pattern except those shorter than 2 mm. These lack the gray, downy base, whereas the larger ones more posteriorly have a downy base which is at least one-half the feather length. The tips of nearly all the gorget feathers are iridescent, and because of their imbrication, the gray bases and intermediate buffy portions of successive feathers are concealed. The gorget area, then, appears as a solid area made of "scales" of varying shades of red. The predominant color seen on this area in bright sunlight is yellowish red or copper. Close examination with different angles of light may reveal shades of greenish-yellow or purplish red. The color of the tips in transmitted light is brownish gray.

Structural colors of the Allen Hummingbird are not here discussed in detail; reference may be made to Allen (1896), Mallock (1911), Strong (1903*a*, 1903*b*, 1905), Gadow (1882), and Newbigen (1896). In figure 6 the character of the refracting structure of the naked part of the barbule is shown. It is the recurved tip of the barbule with hooks that tends to hold the adjacent barbs together, and the greater part of the barbule serves as a color-producing surface. The structure of the iridescent barbs will be discussed in the section on molt and wear.

The interramal area of the adult female has a few iridescent feathers which are similar to those of the male. The number of these occurring on the throat of adult females is highly variable (from one to twenty-two feathers recorded), and for field work on nesting birds the amount of red was used to distinguish individual females. Surrounding the red gorget feathers of the adult female are feathers of similar pattern but with the terminal band smaller and iridescent green instead of red. The numbers of these are also highly variable. The intermediate band of the individual throat feathers of the female is usually pure white instead of deep buff, as in the adult male; this gives a white background for the gorget feathers. The gorget feathers of all Allen Hummers have buffy tips when new, but these tips are worn away rapidly.

Immediately posterior to the interramal region is the submalar region which merges indistinguishably with the malar region below the ear opening and marks a union of the dorsal and ventral tracts. Extending posteriorly from the submalar region to the sternal region is the ventral cervical region which is a group of feathers inserted in folds of the skin of the neck. Posteriorly the ventral cervical region unites with the sternal region at the anterior base of the large pectoral muscle mass. At the point of union there is a branch of the ventral tract that merges eventually with the marginal coverts of the wing, which are different in color. Feathers of this small group I have termed the sternal spur. They are similar to those of the axillar region but smaller.

The sternal region along nearly its entire length is contiguous with the feathers of the axillar region which are characterized by a different color pattern and by their angle of insertion. The feathers of the sternal region are inserted acutely to the skin and are directed anteromedially, serving to

cover the large naked place over the bulging sternum and pectoral muscles. There is a protrusion under the wing of the axillar area; the feathers of this region are inserted posteromedially and cover the posterolateral part of the bird.

The posterior ends of the axillar and sternal regions merge with the markedly different feathers of the abdominal region. These latter feathers are inserted in the same fashion as those of the axillar region and cover the base of the tail. When the bird is flying or perched, the feet are drawn into this downy mass.

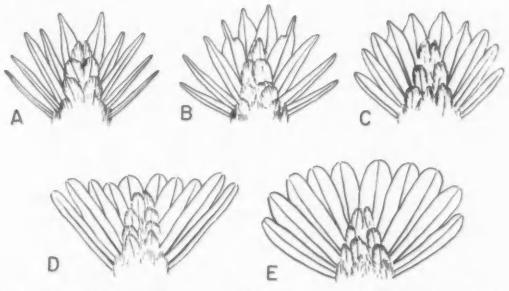

Fig. 3. Ventral views of spread tails of western American hummingbirds showing sexual dimorphism in size and form of rectrices. A, *Selasphorus sasin*, male; B, *Selasphorus rufus*, male; C, *Selasphorus sasin*, female; D, *Calypte anna*, male; and E, *Calypte anna*, female.

Caudal tract.—The rectrices are ten in number and are among the most specialized feathers found in this order of birds (fig. 3). They are specialized for the production of sound in the course of rapid movements during flight displays. The rectrices are inserted at the end of the uropygium which is broadly pointed at an angle of about 95 degrees. On the dorsal side at the point of insertion there are one or two filoplumes which are tufted at the tip with a few barbs. These filoplumes average about 6 mm. in length and lie along the dorsal surface of each rectrix. The purpose of these is obscure.

All rectrices have a rachis and vane that is curved to a greater or lesser degree. This curvature evidently helps to make possible some of the noises produced by the tails of hummingbirds. Measurements given in table 1 show the relative sizes and shapes of the plucked rectrices of an adult male and female taken in good plumage in March, 1938. The bend of the rachis is measured as the distance in millimeters from the center of the rachis to a straight line (chord) from the tip of the calamus to the inner tip of the rachis.

Table 1

Size and Relative Bending of Rectrices of the Allen Hummingbird[1]

Rectrix	Length		Maximum width		Bend of rachis	
	Male	Female	Male	Female	Male	Female
1st	7.7 mm.	7.6 mm.	8.0 mm.	8.8 mm.	0.3 mm.	0.4 mm.
2nd	6.3	7.5	6.2	6.0	0.7	1.0
3rd	6.5	7.2	3.2	4.5	0.7	1.6
4th	3.7	5.1	2.4	3.4	1.5	1.9
5th	2.4	3.3	2.2	2.6	2.1	2.1

[1] In assessing differences between sexes here measured, the reader should remember that females of *S. sasin* are slightly larger than males in both weight and linear dimensions (Pitelka, 1951).

The rectrices of an Allen Hummer vary in size with the sex and age of individuals. These differences are shown in figure 3. The bases of the vanes of all the rectrices are slightly downy and the color of the shafts corresponds to the color of the adjacent vanes. In the following descriptions the rectrices are numbered from the center to the outside.

Rectrices of adult female: Rectrix 1 rounded, spear-shaped, and slightly broader than that of male, tending when worn late in summer to be more sharply pointed; rachis and vanes slightly bowed ventrally (fig. 3). Ventral bowing typical only of first rectrix and to lesser degree of second. All other rectrices of both sexes lie approximately in horizontal plane. Terminal 9 mm. of rectrix iridescent black; rest of feather orange. Rectrix 2 elipse-shaped, becoming slightly pointed in late summer. Markings approximately same as rectrix 1 but in some females small and indistinct white edging occurs. In adult females this edging occurs more frequently on inner vane. Rectrix 3 bent, narrow, oval-shaped, tending to be slightly broader distally. White tip measures on rachis about 4½ mm. long and is wider on inner vane. Proximal to white tip, rectrix 3 has black band measuring 7 mm. on the rachis. It differs from white tip in being broader on outer vane. Remainder of feather orange. Rectrix 4 of similar shape to 3 but relatively narrower. Color markings also similar to rectrix 3 but boundaries between color areas more perfectly transverse. Rectrix 5 same as 4 but smaller, more bent, and relatively narrower.

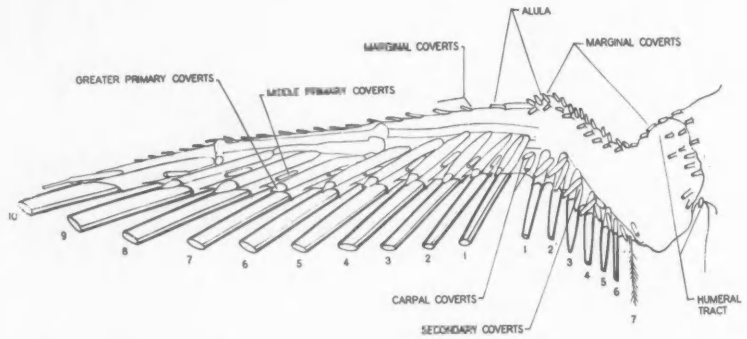

Fig. 4. Pterylography of the wing of *Selasphorus sasin*, dorsal view, approximately ×5.

Rectrices of adult male: The rectrices of the male differ greatly in color from those of the female, all the orange areas being darker. Rectrix 1 about same length and breadth as that of adult female, the widest portion basally, and tapering to tip. With wear, tip may become constricted and thus sharper. A black marking (about 10 mm. long) of varying shape present, running longitudinally to tip. Boundaries of this mark well defined. Remainder of feather dark orange. Rectrix 2 a smaller duplicate of 1 but with relatively broader and larger black marking at tip. Rectrix 2 of adult male of *S. rufus* has characteristic notch near tip on inner web. Rectrix 3 about same length as 2 but distinctly narrower with nearly parallel sides. Tip of outer vane black for 12 mm., inner vane for about 5 mm. Rectrix 4 smaller and relatively narrower than 3, and more bent medially. Black markings similar, but with boundaries less distinct. Rectrix 5 smallest, narrowest and most bent of all the rectrices. Very sharp terminally; this accentuated by wear in late summer. Outer vane extremely narrow and black distally for nearly three-fourths its length; inner vane black distally but for one-fourth its length. It is rectrix 5 that produces most of the noise in the power dive.

Rectrices of immature individuals: After young leave the nest, and before the postjuvenal molt, the rectrices of both sexes of the young resemble closely those of the adult female. I have detected no age difference in the rectrices of the females, but the outer rectrices of the immature males are narrower and the orange color is darker, resembling the color found in the adult male.

Alar tract.—The first six primaries are attached to the fused metacarpals and are situated on the dorsal side (fig. 4). Primary 1 is inserted nearly perpendicular (75°) to the fused metacarpal bone, but progressing distally, the primaries are inserted more acutely until number 6 is at an angle of about 15°. Primaries 7, 8, and 9 are inserted against the posterior border of the bone of the third digit. These all come off at an angle of about 20°. The tenth primary is inserted along the entire posterior border of the second phalanx of the second digit and is bound parallel to it. All the primaries are held

together with a slightly flexible webbing which extends into the region of the secondaries, decreasing in width proximally.

Primary 9 is the longest (33.6 mm. in a male, 31.0 mm. in a female), and in adults of both sexes and in immatures the ninth and tenth protrude an equal distance to form the point of the wing. The wing is more rounded in the females and immature individuals than in adult males, partly because the last three primaries are more curved than those of males and partly because primaries 4 to 8 are relatively longer and thus round out to a greater extent the posterior margin of the wing.

Primaries 1 to 6 have a nearly straight shaft. Primaries 8 to 10 are tapered more or less symmetrically. The others are not so pointed, but are truncate and so conform to the trailing edge of the wing. The shaft is broadest in primary 10; the outer vane of this primary is relatively narrow and, in the adult male, is scarcely visible. This provides a sharp cutting edge, which contributes to the

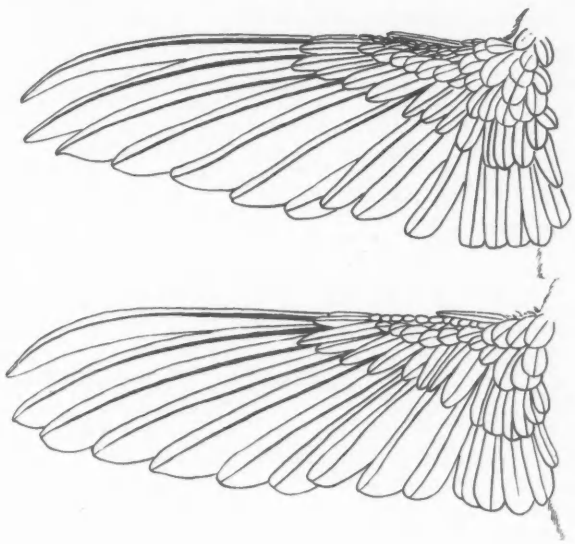

Fig. 5. Outspread wings of *Selasphorus sasin* to show sexual dimorphism in form and size of remiges; male above, female below; primary 10 pulled forward slightly beyond normal position to show its form and size more clearly; ×2.

rattling noise in the flight of the adult male. The shaft is also coarser near the tip of the outer primary of the adult male. Also assisting in the flight sound is the sharper point on the tenth primary of the adult male. In figure 5 the tenth primary of the adult male is shown to be narrower than that of the female.

The secondaries are six in number. The presence of a greater and lesser carpal covert without a corresponding secondary leads one to suggest that a carpal remex was lost in the course of evolution. The individual on which most of the wing study was made had a vestigial seventh secondary (fig. 4), which had a narrow shaft, lacked barbicels, and was plumaceous and nearly white. A corresponding covert was noted that was larger than the vestigial secondary. The secondaries are inserted at about a 60° angle on the posterodorsal border of the ulnar bone. The feathers and their quill bases are largest distally and decrease in size proximally to the last one.

The alula or first digit is not free from the adjacent skin and bears three or four feathers. The largest feather is 6 mm. long, 1 mm. wide, and is appressed along the anterodorsal edge of the wing.

It is the same color as the primaries, dark brown, and thus stands out amongst the green marginal coverts. The other feathers of the alula are indistinguishable from the marginal coverts.

The greater primary coverts begin proximally as tubes solidly bound to the bases of the primaries. They run parallel to the primaries and fill spaces between them. The middle primary coverts are bound basally to the bases of the greater primary coverts, although they do not always run parallel to them.

The under wing coverts of the primaries are in two rows (fig. 2). The under greater coverts are rigidly attached as are the upper greater coverts between the bases of the primaries; they lie proximal to their corresponding remiges. The under middle primary coverts are all attached on the inserted ends of the corresponding primaries.

The secondary coverts are more loosely bound to their respective feathers than are the primary coverts. A greater and lesser carpal covert are present between the bases of the primaries and secondaries. Secondary 1 has a single covert, whereas secondaries 2 and 3 have two. From the fourth to the seventh, the coverts are arranged in confusing manner. There is evidence of a state of diastataxy between the fourth and fifth secondaries. There appear to be three coverts arranged in no order at the base of secondary 4, one of which may belong to a secondary that has been "lost." Secondary 5 has a covert attached to its base; the covert of secondary 6 is placed proximally to one side. There is a seventh covert regardless of the presence or absence of the corresponding aberrant secondary.

Because of the congested condition in the region of the secondaries the relation of the coverts to them is obscure; here the rows of greater and lesser coverts cannot be distinguished clearly. The cause for this confusion probably lies in the extreme evolutionary reduction that has taken place in the proximal structures of the wing. During this adaptation for a highly specialized flight, the feather rows have probably shifted in relation to one another and have lost their original arrangement.

The under secondary coverts are less confusing than are the upper ones. The two rows remain distinct, but the relation of each covert to its secondary is difficult to make out. There are several additional feathers on the under side of the wing proximal to the under secondary coverts.

The marginal coverts are small distally and larger proximally where they blend with those of the humeral tract and with the sternal spur.

The humeral tract is a single row of feathers running anteroposteriorly along the humerus. The feathers are very similar to those adjacent on the dorsal region of the body.

The feathers of a male and a female were counted. Those of the male totalled 1,459 and those of the female, 1,659.

NOTES ON MOLT AND FEATHER WEAR

The molt of the Allen Hummingbird was not studied intensively because of the limited number of specimens available. Young were kept in captivity with the hope that they would display the complete postjuvenal molt, but the longest period they survived after leaving the nest was three months. This aided materially, however, in providing information on the immature plumage. Most of the facts concerning molt and wear reported here were gleaned from museum skins. *Selasphorus rufus* and *Selasphorus sasin* were studied together on the assumption that there is little or no difference in the molt cycles of the two species; 164 specimens of *rufus* and 57 specimens of *sasin* were available in 1938, in the Museum of Vertebrate Zoology.

Fade and wear of feathers.—Most of the species of hummingbirds in the United States have large iridescent green areas on the upper parts, at least in females. The shades of these greens differ among the species, and of the common hummingbirds in California, *sasin* may be distinguished from all except *rufus* by the coppery or golden cast to the green. The golden cast is due in part to the character of the tips of the barbs and to the structural color of the green portion of the feather tip. The iridescent feathers, when new, have buff tips that are loose because of the small number of barbules and barbicels present. These tips are more susceptible to wear and thus serve as an aid in determining the age of the plumage. The buff tips when examined from a distance seem to assist in producing the golden-green appearance and as the tips wear, some of the golden cast is lost. The golden color of the green portion of the feather in time may fade,

leaving a purer green with a slight bluish tint. Evidence of this fading can be seen by examining a well worn feather. The more terminal portion of the green that is exposed to the surface and that is not covered by part of another feather is pure green, whereas that portion of the feather that is concealed by overlap remains golden green.

Wear and molt in the males.—Time of acquisition of the adult plumage is not known, but it is probably assumed sometime in the early part of the calendar year while the birds are on their winter range. Most work was done on a series of 64 adult male *rufus*; but unfortunately these specimens were all taken between February 29 and July 29, and there is thus a critical gap in the data needed to describe the plumage cycle.

A great variation was found in the degree of wear and fading exhibited by individuals at the same time of year. This may be a result of differences in environment or in activity of individuals rather than a difference in time of molt. However, further study is required on this point.

The green crowns of the adult males were examined for new incoming feathers and none was found, which probably indicates that the crown feathers of adult males are obtained some time between dates that are not represented by the specimens examined. Fourteen specimens representing the period from February 29 to April 7 had crown feathers classed as "new." Specimens obtained after this date, and up to June 6, comprised a heterogeneous group of 37 specimens. In this group occurred individuals with new as well as with partly worn crowns. Eleven specimens from June 6 to July 29 had crowns either partly worn or badly worn. The 17 adult male specimens of *sasin* taken between March 3 and July 31 exhibit crowns all of which are partly worn.

It is apparent from these data, then, that the chief and perhaps only molt of adult males of *rufus* and *sasin* occurs but once a year and some time between July 31 and February 29, which would be while they are on their winter range.

The gorget, because of its structure, serves better as a criterion of wear than any other feather area. It is necessary at this time to describe the structure of these feathers in order to give a basis for the account of molt and wear.

The iridescent gorget feathers are about one-half their definitive length before they break through the sheaths. The terminal portion that produces the red iridescence occupies but one-third the total length of the feather. Because of the imbrication of these feathers, a mass effect of this brilliant color is produced. The rachis of the gorget feather does not extend to the tip, but the axis of the feather is taken over by the two terminal barbs which are parallel, thus forming the tip of the feather (fig. 6). The terminal part of these feathers is blunt and rounded. The iridescent color of the gorget feathers is produced by the proximal parts of the barbules. This part in each barbule is smooth and rod-like and is devoid of barbicels. Distal to the specialized, color-producing part is a tip (pennulum) that is curved nearly at right angles to the basal part of the barbule. Barbicels occur on the pennula only and serve to hold together the barbules on one side of a barb, but they do not unite the barbules of two adjacent barbs.

In studying the wear of gorget feathers, three stages were recognized: stage 1 (new), stage 2 (slightly worn), and stage 3 (worn). These are shown in figure 6.

All feathers of the gorget may not be in the same stage of wear at one time. Some parts wear more rapidly than others. This is caused not by differences in structure but is a result of the position of attachment in the gorget area. The feathers of the "tail," or elongated posterolateral part, wear more rapidly than feathers of any other part. This is correlated with the movement of the neck of the bird. These "tails" are long enough to abrade on the bends of the wings during the almost constant turning of the head of the adult males when perched. In most individuals, the gorget "tails" have reached stage

3 by the time the rest of the gorget is at the beginning of stage 2. Most central gorget feathers are worn to stage 3 by late April and early May.

Feathers of the gorget also may fade. This fading makes the gorget slightly more yellowish. The portion of the red tip that is covered by the overlap of another gorget feather remains its original color. A plucked worn feather therefore exhibits an iridescent part that is bicolored. Fading of the gorget feathers can be noticed only on a few specimens that were taken in May, June and July.

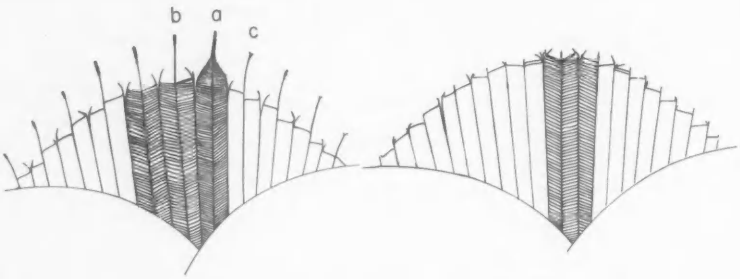

Fig. 6. Portions of two iridescent gorget feathers of *Selasphorus sasin*, unworn at left, worn at right; stages of wear shown at left are (a) new feather, (b) and (c) intermediate stages of wear; at right, feathers with broken barb shafts are shown in an advanced stage of wear.

Tracing wear and molt in the feathers of regions other than the gorget and crown is more difficult. With age the orange on the breast and belly becomes slightly lighter and less brilliant. The primaries lose their slight metallic sheen and become brownish, and the tips, especially that of primary 1, become ragged and wear to a sharper point. Parts of the barbs break away from the rachis leaving a narrower structure which theoretically should make a flight sound louder than that of unworn feathers.

Fading, wear and molt in females.—Females on their northward migration appear to be growing new feathers. Adult females of *rufus* and *sasin* taken in early March have new iridescent red gorget feathers that are in stage 1 or early stage 2 of wear. The throat areas of these same birds also show some gorget feathers that are badly worn and are in stage 3. Moreover, the finding of pin feathers on throats of adult females taken in the summer indicates that there is a slow but continuous molt of feathers of this area while the birds are still on their breeding range or in migration.

With this apparent continuous change in the feathers of the throat area in adult females, there is also a change in its markings. Adult females at the beginning of the year have more red iridescent feathers than later. As molt progresses there is a tendency for the adult to acquire throat patterns resembling those of the immature females. More of the new incoming feathers have small green tips than red ones, and in the series of specimens of *rufus* taken in July and August, it is difficult to distinguish adult from immature females on the basis of throat characters.

Females arriving on breeding grounds have green upper parts which appear fairly worn, and those specimens positively identified as adult females in August and September show greater wear than immature individuals of the same sex.

Postjuvenal molt and acquisition of the adult male plumage.—Because of the similarity between immature and adult females, accurate information concerning the postjuvenal molt could be obtained from study of the males only. Virtually no information

concerning molt is present in the literature, and the time and sequence of changes is not fully known. All immature male specimens in the collection up to October 15 show no sign of normal postjuvenal molt. The period of the postjuvenal molt is therefore not known, but it probably occurs while the birds are on their winter range.

Four male specimens of *rufus* taken between March 21 and April 17 in southern and central California are in a molt which is tentatively considered to be a first prenuptial molt because of the timing relation to breeding. Rectrices of all three are like those of adult males, but one specimen possesses only four adult rectrices (the two central pairs) while the others are immature, with pinkish white terminal spots.

Feathers of the upper parts are new on all four specimens, with the exception of those at the base of the bill and on the forehead. Here the old feathers are very worn and dull brown in color. Numbers of old forehead feathers present vary, and replacement of these apparently is not closely correlated with the general advance of molt on other areas. One of the four specimens that is otherwise farthest advanced in molt actually has more old feathers on the forehead than any of the other three.

Remiges of all four specimens appear to be immature in character, with the two outer primaries broad. They are also noticeably faded to a light brown, and no metallic sheen is present. Males in such transition plumage make a low humming sound characteristic of the females and immature individuals, and not the loud rattle produced by the sharp outer primary of the adult male.

The under parts of all four specimens are in an advanced stage of molt. All show the orange under tail coverts, the orange sides and the pure white lower neck area characteristic of the adult male. One retains some of the whitish feathers characteristic of the central belly of the immature.

Most of the feathers of the throat are like those characteristic of the immature but appear faded due to the loss of much of the green on the feather tips. This makes for a more buffy appearance of the throat. In three of the specimens there are present both new and old iridescent red gorget feathers, and one has four of the old gorget feathers and none of the new. All four specimens, however, have new gorget feathers still sheathed. The new feathers usually appear first on the posterocentral portion of the gorget area.

Of interest is a fifth male of *rufus* taken on April 16, 1904, at Pasadena, California, that also is in the prenuptial molt. It is typical of adult males in all respects, including the sharp outer primary, but the gorget area appears new, and there are many pin feathers in it. Replacement in the gorget area, therefore, probably occurs first centrally and posteriorly, and then proceeds anteriorly.

Still another male of *rufus* observed on April 7, 1938, in Berkeley, California, indicates the occurrence of the first prenuptial molt. It was observed closely at a distance of eight feet and appeared to be coming into first breeding plumage and hence was similar to the specimens just described. Noticeable was the well worn patch of feathers on the forehead and crown. These feathers were grayish brown contrasting with the green present more posteriorly. The throat appeared to be almost solid light buff. The flight sound was distinctly like that of females, and this fact was strengthened by the contrast noted between it and an adult male hovering five yards away.

Thus, while there appears to be a single annual complete molt in adult males, molt in females and particularly first-year birds of both sexes appears to be more protracted, complex, and diffuse. For *rufus*, which has a larger and more northern distribution than *sasin*, there is evidence for a fairly intensive prenuptial molt in first-year birds. This could conceivably be the last phase of a protracted and interrupted postjuvenal molt.

SUMMARY

The pterylography of the Allen Hummingbird (*Selasphorus sasin*) is described and comparisons are made with one other hummingbird species and also with a few passerines and woodpeckers for which adequate information is available. Frontal and dorsal apteria occur; the former may be characteristic of the Trochilidae and other closely related groups. The rectrices, 10 in number, are specialized in form and structure to serve in production of flight sounds and they are sexually dimorphic. This is also true of the primaries, which are 10 in number. An irregularity in the serial relations of secondaries and their coverts suggests evolutionary loss of some secondaries and a considerable degree of modification in this sector of the wing.

Successive degrees of plumage wear are described and the possible uses of these characteristics as criteria of sex and age are suggested. Certain observations on molt based on specimens of *Selasphorus sasin* and *Selasphorus rufus* are presented. Postjuvenal molt occurs some time after mid-October. In *rufus*, at least, a first prenuptial molt (possibly the last phases of a protracted postjuvenal molt) occurs in first-year males, but otherwise there is no evidence for more than one complete annual molt. This occurs between October and February on the wintering grounds. In females there are local body areas, such as the throat, which appear to molt over a longer period and in a more diffuse manner than in males.

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Sacramento, California, October 1, 1955.

THE ANNUAL REPRODUCTIVE CYCLE OF THE CALIFORNIA GULL
I. CRITERIA OF AGE AND THE TESTIS CYCLE

By DAVID W. JOHNSTON

In the majority of avian species, and especially in small passerine birds, maturity is attained in the first year of life so that only two postjuvenal age groups are distinguishable, immature and adult. In many of the larger, non-passerine species, however, more than two postjuvenal groups have been described or suspected. This is true of gulls which undergo a protracted maturation period that sometimes involves three years. Prior to maturity, characteristic and distinctive plumages and molts can be correlated with specific ages, and certain recent studies of banded birds have corroborated the plumage sequences which had been indicated previously by the study of molting birds.

The present work deals specifically with California Gulls (*Larus californicus*) of known ages, identifiable on the basis of plumage and other characters, wherein special attention is devoted to annual conditions of reproductive anatomy and physiology in the subadult age groups as well as in adults. Previous investigations of reproduction in birds have in only a few instances been studies of complete annual cycles of both sexes, since the primary interest heretofore has been placed on male birds just before and during the breeding season. It is the purpose of this study to determine correlations among breeding activity, reproductive anatomy, migration, and age in both sexes, and to compare and contrast these data for the California Gull with previous investigations of annual reproductive activities in other birds.

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MATERIALS AND METHODS

Work was begun in August of 1951 and terminated in July of 1953. Until June, 1952, only sporadic observations were made and occasional birds collected, but, from June, 1952, to July, 1953, regular monthly observations and collections were made. During the fall, winter and early spring months, field work was carried out in the San Francisco Bay area of California where most of the gulls were collected at the garbage dumps of Oakland, Alameda, San Leandro, Berkeley, Albany and Richmond. During the late spring and summer months, most of the field work was done at Mono Lake, California, but some birds were obtained also from Honey Lake. Nonmigratory birds were collected in the San Francisco Bay area and at Clear Lake, California.

A total of 485 birds was taken over the two-year period, about 95 per cent of them in 1952–1953. A breakdown of this total according to sex and age is presented in table 1. The few specimens taken in 1951–1952 have been compared critically with birds of similar dates in 1952–1953 and in most instances have been included in the samples

since no significant differences attributable to possible annual weather fluctuations were found between the birds collected in the two years.

Table 1

Numbers of Birds Collected from 1951 to 1953

	Males	Females
First-year	49	36
Second-year	48	52
Third-year	65	46
Adult	85	104
	247	238

A sample of five males and five females of each age group for each month was considered to be adequate for this investigation, although in some months this goal was not achieved primarily because sexual dimorphism is absent in this species. In the discussions of age criteria and various aspects of reproduction which follow, it will become apparent that, with relatively few exceptions, members of a sample of five show little variation in a given characteristic during the winter or nonbreeding months. Birds taken in the spring and summer, however, tend to be more variable, this being especially true of subadults as regards colors of soft parts and testis sizes. Even with these expected variations, it has been possible to indicate a normal or average condition for a characteristic according to age group and month.

DISTRIBUTION AND MIGRATION

The California Gull breeds on fresh-water or saline inland lakes of western North America from Great Slave Lake, Canada, south to Mono Lake, California, and from Klamath Lake, Oregon, east to Stump Lake, North Dakota. During the summer months, nonbreeding birds, principally subadults, occur casually along the Pacific coast from southeastern Alaska to Sonora, México. The winter range is almost exclusively the Pacific coast from British Columbia south to Oaxaca, México. Subadults are more plentiful than adults in the southern part of the winter range (Willett, 1938).

This species undergoes an east-west migration, at least in the fall. Birds banded as nestlings at Mono Lake, Klamath Lake, and Great Salt Lake have been recovered in winter along the Pacific coast with the preponderance of records being from San Francisco and Monterey bays, California (Woodbury and Knight, 1951).

Numerous observations indicate that in spring migration probably the bulk of the population moves into the Mono Lake area via the Owens Valley and that many of the migrants that utilize this route move on to other colonies farther to the north. Since there are recoveries in April of banded birds from Mono Lake in the San Francisco Bay area, and since there is a general tendency for this species to return to its natal grounds for breeding, it is also evident that a certain portion of the population reaches the Mono Lake area over the crest of the Sierra Nevada, thus carrying out a west-east migration in the spring.

After breeding, the gulls wander widely, especially throughout the montane lakes of the Sierra Nevada. For the fall migration there is additional evidence from observations and banding records that most of the Mono Lake population utilizes a transmontane route rather than the Owens Valley, although some birds probably use the latter route, too. Fourteen out of 17 recoveries of banded birds from Mono Lake in the late summer and early fall are from California localities north of Monterey Bay. This supports the idea that fall migration is essentially east-west and transmontane.

Field observations at local garbage dumps in the San Francisco Bay area indicate that, owing to competition with the larger species of gulls in winter, most of the California Gulls are absent from these favorite sites whereas they are common there in the late summer, fall, and spring. There is some evidence from banding records that some of these gulls move farther south: out of seven midwinter recoveries of birds which had been banded at Mono Lake, five are from scattered points around Los Angeles or farther south. Many of the gulls in the San Francisco Bay region, however, probably just move into adjacent habitats such as city parks and beaches.

In the early spring (March) a rather marked influx of California Gulls is noticeable at the garbage dumps whereas they had been absent, for the most part, during the winter. This increase might be attributed to one or more causes. Since it is coincident with the decline in numbers of the larger species of gulls, it is possible that the California Gulls are moving back to the dumps from the adjacent habitats just mentioned. It is also conceivable that there is an influx of birds which are migrating northward. The first of these two explanations is the more likely.

As further evidence that birds may migrate south from the San Francisco Bay area in winter and then return in the spring, it is possible to demonstrate a change in sex ratio from fall to winter to spring. If the birds collected at random in this area are enumerated according to sex and month of the year as in table 2, it can be seen that in the late summer and early fall there are almost equal numbers of males and females, but in midwinter more females are present. In March the ratio becomes balanced again. These data would suggest that either males migrate farther south or that they are absent

Table 2

Numbers of Males and Females Collected in the Nonbreeding Months

Month	Males	Females	Males : Females
August	14	14	1 : 1.0
September	19	21	1 : 1.1
October	24	27	1 : 1.1
November	18	19	1 : 1.1
December	12	29	1 : 2.4
January	10	20	1 : 2.0
February	9	21	1 : 2.3
March	18	15	1 : 0.8
April (first half)	7	14	1 : 2.0

from the dumps whereas the females are present. The first of these two hypotheses is favored, because if competition is a vital factor in keeping the species away from the dumps, it is certainly true that the males which are larger would be better competitors with the larger gulls than would the females. Differential migration of sexes has been demonstrated for other species of birds (Bullough, 1942; Mewaldt and Farner, 1953). There is also some evidence in table 2 that males migrate before females since in the first half of April relatively few males were collected. These samples are admittedly small, so the conclusions drawn therefrom must be tentative.

DESCRIPTION OF THE MONO LAKE COLONY

For many years a large colony of California Gulls has bred on the islands of the highly saline Mono Lake. Dawson (1923) found the birds nesting on both Negit and Paoha islands and estimated about 850 nesting pairs on Paoha in 1919. The main colony, however, was located on Negit. In more recent years residents claim that the Paoha

colony has been abandoned, perhaps due to the introduction of feral goats on the island, and, since at least 1938 when Nichols (1938) visited the lake, only Negit Island has been utilized.

The lake was visited on August 25, 1951, and in 1952 observations and collections were made from the shore at two-week intervals from May 16 to July 17. Between March 14 and July 20, 1953, five trips were made to the lake and Negit Island. A summary of the important events in breeding in 1952 and 1953 is presented in figure 1.

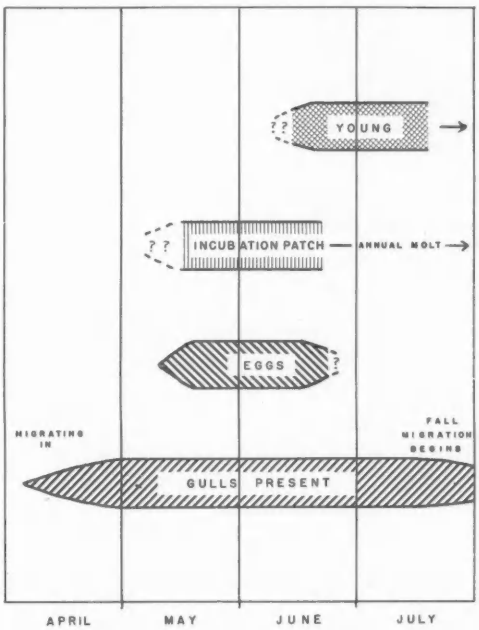

Fig. 1. Diagram of events of the breeding season at the Mono Lake colony in 1952 and 1953; question marks indicate suspected but unobserved conditions.

There were no gulls present on March 14, but by April 28 large numbers were present on and around the island. At this time there were no nests, and the birds lacked incubation patches. Most of the gulls had nests with eggs by May 15 at which time all adults collected had incubation patches. The nests were about six feet apart and were placed, for the most part, in the sandy pumice under the partial or complete shade of greasewood plants (*Sarcobatus vermiculatus*). Several eggs taken at random from nests contained embryos two to four days old, indicating that some eggs in the colony were laid about May 11. On May 29 and 30 embryos were, on the average, about two weeks old. In two different parts of the colony, 100 nests were tabulated, and the results are presented in table 3. These data, plus observations at other colonies (Honey Lake, California; Johnston and Foster, 1954:40; Pyramid Lake, Nevada, Marshall and Giles, 1953:113), show that the mean clutch size for this species is about two. On June 19 and

20 most of the eggs had hatched, some of the young being about one week old. Adults had incubation patches, most of which were beginning to refeather, this phenomenon marking the early stages of the annual molt.

Table 3

Summary of Two 100-Nest Censuses, May 30, 1953

Nest contents	East census	North census
One egg	16	12
Two eggs	66	54
Three eggs	17	34
Four eggs	1	0
Mean	2.0	2.2

From 3000 to more than 5000 gulls were estimated to be present at the Mono Lake colony, the range being partly a reflection of the difficulty in attempting to estimate flying gulls. Young (1952) has maintained that this colony is decreasing in numbers; he estimated that there were 1500 birds whereas Nichols estimated 3000 in 1938. Until a series of annual censuses is available, it is unwise to conclude on the basis of the existing sporadic and perhaps inaccurate records, the trend in numbers of this colony.

CRITERIA FOR DETERMINING AGE

It has proved necessary to re-examine the several criteria which have been used to determine age in the California Gull. In the past, various authors have utilized plumage and colors of soft parts, and to these I have added the length of the bursa of Fabricius, a dorsal evagination of the cloaca. By using these characters individually or collectively the age of a given bird may be determined as follows: first-year, 0 to 12–14 months of age; second-year, 12–14 to 24–26 months; third-year, 24–26 to 36–38 months; and adult, 36–38 months and older. The two-month interval is roughly an indication of the period of the annual molt at which time the bird is changing its distinctive plumage. Sexual dimorphism in the characters for determining age is absent, except perhaps in the bursa of Fabricius.

PLUMAGES AND MOLTS

Dwight (1925) considered the California Gull to be one of the gulls which has a four-year plumage cycle, that is, it molts into the adult plumage at the beginning of the fourth year of life. Following this generality he gave a detailed description (pp. 197–202) of the plumage and soft-part colors of each of the four ages, plus a limited amount of information on molts. Brooks (1943) disputed Dwight's interpretation, maintaining that the species undergoes only two complete molts and has only three plumage or age groups. He did not recognize the third-year plumage of Dwight.

Brooks' interpretation was erroneous because he considered a second-year bird (no. 1492, Comox, B. C., August 26, 1927) to be molting into an adult plumage. This specimen is molting, but, in view of the fact that new, smudged alulae are coming in and some of the new rectrices, which have not completely broken their sheaths, have dusky markings on the white background, this bird evidently is molting into the third-year plumage described by Dwight and summarized in a later section of this paper. Why Brooks denied the usual occurrence of this plumage is difficult to explain because there is a "typical" third-year bird in his collection (no. 8842, Okanagan, B.C., May 29, 1938) which is markedly different from the second-year bird in the same tray.

Poor (1946) in his study of plumage and soft-part variation in banded Herring Gulls (*Larus argentatus*) discussed this problem, stating that (p. 136) "Brooks (1943)

disagrees with Dwight on the interpretation of the plumages of the California Gull (*Larus californicus*). Collected banded birds would resolve the conflict of these two authorities." This has been the approach undertaken by Behle and his students at Great Salt Lake, Utah. Birds banded as nestlings have been recovered in subsequent years at the breeding colonies, and the results of these investigations (Behle and Selander, 1953) have corroborated the findings of Dwight, both as regards plumages and colors of soft parts of the four age groups.

Despite this clarification, there is need for further analyses of molt. If four clear-cut plumage types can be recognized on the basis of banded material, it should be possible to establish this same sequence by utilizing a large sample of molting birds. An opportunity of this kind was afforded in the present study. Through the kindness of W. H. Behle, I was able to compare my unbanded specimens with representatives of each age group from the banded birds which are obtained at Great Salt Lake. In addition, four banded birds were taken by me, and these have been compared with banded and unbanded specimens.

In the discussion which follows only a general summary of the main plumage features is given supplemented by comments on deviations. Downy young and postnatal molt are not discussed. Beck (1942) gives an adequate description of these phases in the plumage cycle. Winter and nuptial plumages within a given age group are not separated because usually the two are rather similar. As will be pointed out later, however, such a separation is justified in some age groups because there is an extensive prenuptial molt of body feathers, more so than has been previously recognized.

Molt in relation to migration.—In all age groups, except for an occasional individual, the prenuptial molt is completed before the birds migrate. This statement must be made with some reservation because no birds were collected in early April at the breeding colony; it is possible that some of the earliest arrivals are still molting. On the other hand, the annual molt is rarely, if ever, completed before the birds leave the breeding colony. As figure 2 shows, all age groups are in their annual molt in June and July before they leave Mono Lake, and birds of all ages which have just returned to the San Francisco Bay area in August are still molting (except for the primaries and tail of first-year birds). Rectrices are apparently molted during and/or after migration; they were not found to be molting prior to migration.

Duration of molt.—It is significant to compare the present findings on duration of molt (fig. 2) with those given by Dwight (1925) and by Behle and Selander (1953). Undoubtedly, Dwight examined relatively few molting birds because he did not record second-year and adult birds as being in their annual molt in June and July, but, as can be seen in figure 2, this is the usual condition except for the rectrices. The prenuptial molt in this species involves primarily the body feathers, and from figure 2 it is apparent that this molt in third-year and adult birds occurs during February and March. Behle and Selander give the periods for the prenuptial molt as February to April for third-year birds and March and April for adults. A combination of their findings with those of the present paper would probably give a more accurate total picture of the duration of the prenuptial molt.

First-year.—By definition, this first-year category is intended to include three plumages described by the authors previously mentioned, namely, juvenal, first winter, and first nuptial. Except for the effects of fading and wear, and except for a few minor differences in seasonal appearances to be described later, I have found no obvious or consistent differences among these three plumages, and for this reason have combined them. This plumage type or age group spans a little more than a twelve-month period because it begins with the plumage assumed at the postnatal molt, acquired by the Mono Lake

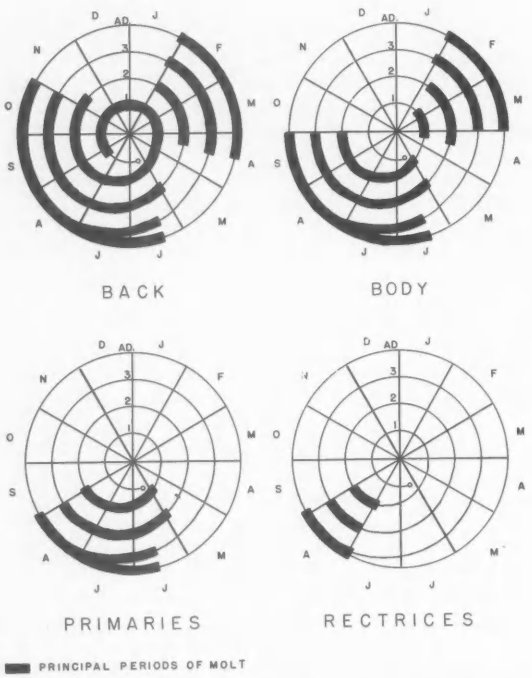

Fig. 2. Molt cycles in the California Gull. Body includes head, neck, breast, abdomen and flanks.

birds in late June and July (late May and June at Great Salt Lake). Birds during the first year are characterized by having blackish brown primaries, rectrices with broad and variable brown and white barring, and underparts, head and neck mottled with brown and white. As Behle and Selander indicate, the back or mantle changes from the brown and white pattern in the first fall and early winter to an admixture with pale blue-gray feathers in the first spring.

A banded female of this age group was taken on October 17, 1952, at Oakland, Alameda County, California. It was banded at Yellowstone Park, Wyoming, as a nestling on July 16, 1952. Its plumage was the same as that of unbanded birds generally considered to be in their first year and as that of another banded first-year bird taken by W. H. Behle at Great Salt Lake.

According to both of the major studies on plumages cited, a partial postjuvenal molt supposedly occurs from September into the winter. Apparently this is not true in most instances, at least as regards body feathers. In at least 46 birds examined between July 31 and January 1, relatively few showed any signs of over-all molting. As far as the body areas (explained in fig. 2) are concerned, no molt was found until October 29, and in the following two months it occurred in only 5 out of 20 birds. The winter, then, is not a time of principal molt of these feathers in this age group. The upper back, or "mantle," however, showed a rather continuous molt beginning in August and extend-

ing, in most birds, on into the spring. Thus, it would appear to be more accurate to speak of a first winter molt, involving, for the most part, only the feathers of the upper back until February when a rather extensive molt of the body, head and neck areas commences. During the spring months, these areas are still mottled with brown and white, although the over-all appearance is somewhat lighter than for young birds immediately after they leave the colony the previous year.

The first annual molt begins in most areas of the body before the annual molt in any of the other age groups. This is correlated with the fact that birds of this age group do not breed. As far as I was able to determine, the first annual molt is complete.

Second-year.—The first annual molt is a transition between the first-year and second-year plumages, and, largely for the sake of convenience, the second-year plumage is assumed to begin on the first of August, even though the molt might not be quite complete.

Again, I have combined the winter and nuptial plumages in this age group, and, except for a few body areas, this seems to be a logical procedure. The second-year plumage is characterized by gray-brown primaries as opposed to blackish brown in the first-year, by an occasional primary with a faint whitish mirror showing on the inner vane, by gray-black rectrices with a basal portion lighter and with less barring than in the first-year birds (see Dwight, *op. cit.*:355, fig. 112), and by a body generally mottled with gray brown but whiter than in first-year birds. The mantle is usually entirely blue gray, but there may be a scattering of gray-brown feathers. There is considerable variation in patterns of the secondary coverts. In most birds some or most of any row may be blue gray, but usually the greater secondary coverts are mottled with brown and white, somewhat similar to but with less broad areas of white than in the first-year birds. Gray secondary coverts are more frequent proximally. Also, the first four primaries may be either grayish white or gray brown like the distal ones.

One banded female was taken at Bay Farm Island, Alameda County, California, on March 4, 1953. It had been banded at Pyramid Lake, Nevada, on July 6, 1951, and was therefore in its second-year plumage. This bird was identical with unbanded birds of the same age group and with a banded representative from Great Salt Lake.

During the fall and early winter, birds in the second-year plumage continue to molt a few body and back feathers, but the back molt is not as continuous as it is in first-year birds. Prenuptial molt commences in January and continues until April during which time the new feathers of the body, head, and neck may be replaced with white or gray-brown tipped feathers. In April and May, these birds have white heads and necks mottled or streaked with dark markings, and their underparts may be completely white or partly gray brown.

Third-year.—This is undoubtedly the most variable plumage in the species. In general, third-year birds differ from second-year birds by having black and white-tipped and/or black and white-mirrored primaries, all white underparts and the black of the rectrices confined to a narrow terminal or subterminal band. It is necessary to know the variations in these areas and their combinations so that the age can be correctly determined.

In almost every bird, either the ninth or tenth primaries or both have a subterminal white mirror on one or both vanes. The first four primaries are entirely gray except for number 4 which may have a subterminal black band. At least the distal five or six primary coverts have blackish outer and somtimes blackish inner vanes. The four alular feathers almost always have distal blackish vanes, but occasionally one or more of these are gray. The secondaries are most commonly gray with blackish smudges distally on their outer vanes. Some or nearly all of these may be entirely gray. Secondary coverts

are exceedingly variable, but usually almost all of them are gray as in adults. There may be an occasional gray-brown lesser covert which perhaps was not replaced from the second-year plumage. The median coverts are almost without exception all gray, but the greater coverts may be gray or brown and white-edged as in second-year birds. In the latter instance, these do not appear to represent feathers which did not molt from the second-year because they have a grayer appearance than similar feathers in the second-year birds.

The mantle is entirely gray and the underparts are white. In winter the head and neck have a streaked appearance.

Variation in the rectrices runs the gamut from a broad, subterminal or terminal black band to completely white in rare individuals (see Behle and Selander, *op. cit.*, plate 7). Sometimes only one or two feathers have a single black spot. The few individuals (four) that had a completely white tail were judged to be third-year on the basis of other plumage characters, colors of soft parts, and the length of the bursa of Fabricius.

Out of 111 specimens of this age group, I obtained only one which lacked blackish alulae. It had, however, most of its secondaries with black smudges, much black in the tail and the typical third-year soft-part colors of that season. Blackish alulae against the background of blue-gray secondary wing coverts, usually involving all four feathers, is one of the most constant characters of third-year birds.

The back and body areas show about the same duration and frequency of molt as in second-year birds. The prenuptial molt, involving back, body, head and neck feathers, lasts from the end of January until about the first of April and results in a head and neck which are sometimes entirely white, although usually a few dark streakings remain.

The third annual molt begins in the middle of June in contrast to the commencement of this molt in the younger age groups at the end of May. The difference is explained partly by the fact that some third-year males breed. Nonbreeders of this age group apparently do not molt any sooner than the few that breed.

Of particular importance has been the collection of several birds which were molting from the third-year into the adult plumage. One of these shows a new gray alular feather and three old blackish ones. Others show old third-year primaries with a small mirror that are being replaced by primaries with a large subterminal mirror and blackish-smudged secondaries that are being replaced by entirely gray secondaries.

Adult.—These birds have blue-gray backs, wing coverts and alulae, outer primaries with black distal portions and white tips, primaries 10 and usually 9 with a white subterminal mirror or long white tips involving one or both vanes, blue-gray secondaries with white tips, and all white tail, underparts, head and neck. In the fall and winter, the head and neck are streaked. In contrast to the variable third-year plumage, adults were found to be more uniformly alike in the 189 birds collected, but Behle and Selander collected at least 8 specimens the age of which was difficult to determine correctly. In the present study by using a combination of characteristics, it was possible to determine the age of all specimens. Some of these have already been discussed in connection with third-year birds. In order to show some of the exceptional variations in this age group, the few variable adults which were collected and their characters are given below; only the characters which deviate from the usual adult plumage are mentioned, these birds otherwise being like typical adults: (1) Four birds, each of which had one partly blackish alular feather. This is apparently an expected variation in adults because Behle and Selander obtained a banded adult with this feature. (2) One bird with three blackish alulars and five secondaries with small black smudges. (3) One bird with a small black spot on two rectrices. (4) A banded four-year-old female was taken on January 30, 1953, at Albany, Alameda County, California. It had been banded on June 4, 1949, at

Great Salt Lake and was therefore in an adult plumage. It has one partly blackish alular feather. Erroneously, I reported to Behle and Selander (*op. cit.*:256) that this bird had a white tail "with numerous pale dusky markings," but careful re-examination of these markings has revealed that they are adventitious stains. The primary coverts of this bird are not dusky, and the secondaries are blue-gray.

During the fall most of the adults show some molting back feathers, and even in November and December occasional birds were molting some of these feathers. From the end of January to about the middle of April, a prenuptial molt of these feathers was very noticeable. Somewhat similarly, molt of body feathers was found sparsely in some adults from the end of September until November, but it was mostly lacking during the winter until the end of January at the commencement of the prenuptial molt. The prenuptial molt, involving feathers of the back, head, neck, abdomen, breast and flanks, is more extensive and intensive in adults as compared with the other age groups, and it is as extensive and intensive as in the annual molt. Adults, at the culmination of the prenuptial molt, and prior to spring migration, have completely white heads and necks.

The annual molt is approximately the same as in third-year birds. This is as one would expect since third-year birds molt into the adult plumage at this time. Adults begin to molt soon after or as the eggs are hatched, and, as far as I was able to determine, males and females begin this molt at about the same time. Since both third-year and adult birds begin the annual molt later than the first- and second-year birds, it is instructive to note that Wynne-Edwards (1939) has found a comparable condition in the Fulmar (*Fulmarus glacialis*) in which species the nonbreeding immatures begin to molt sooner than adult breeding birds.

COLORS OF SOFT PARTS

One of the most useful sets of characters used in determining the age of gulls is the color of the soft parts. In the several major works (Dwight, Brooks, Behle and Selander) which have dealt with this in the California Gull, there have been considerable differences in the descriptions. The discrepancies have been due primarily to normal color variation within an age group (for variation in a single character in a given age, see Behle and Selander, *op. cit.*, table 3, p. 247). As in most of these previous works, color notes in the present study were taken under field conditions on a purely subjective basis without reference to any standard color key. With the possible exception of Dwight, other workers have not attempted to give a complete annual picture of these characters, and even Dwight was somewhat sketchy and generalized.

In none of the works cited or in the present study has any consistent sexual dimorphism been found in the colors of the soft parts. Therefore, in the discussion to follow, the data for the sexes are combined.

Bill.—A summary of seasonal variations in bill color for all age groups is presented in figure 3. These diagrams represent average conditions of coloration only, for color variation may occur between birds of the same sex and age taken on the same day. If one-half of the birds in a given age group during a given month had bill parts of one color and one-half another color, both of these colors are presented in the figure; for example, during April approximately one-half of the adults had an orange-red spot on the lower mandible, but an equal number had this spot vermilion.

Birds from recently hatched eggs on June 20, 1953, had bills entirely black except for the light pinkish tips and the egg tooth. As the birds grew to be juveniles, the basal portion began to lighten and the tip remained a creamy white (Behle and Selander, *op. cit.*:245). Soon after leaving the breeding colony in July, however, the original coloration was more or less reversed because at the end of July a bird-of-the-year had a bill

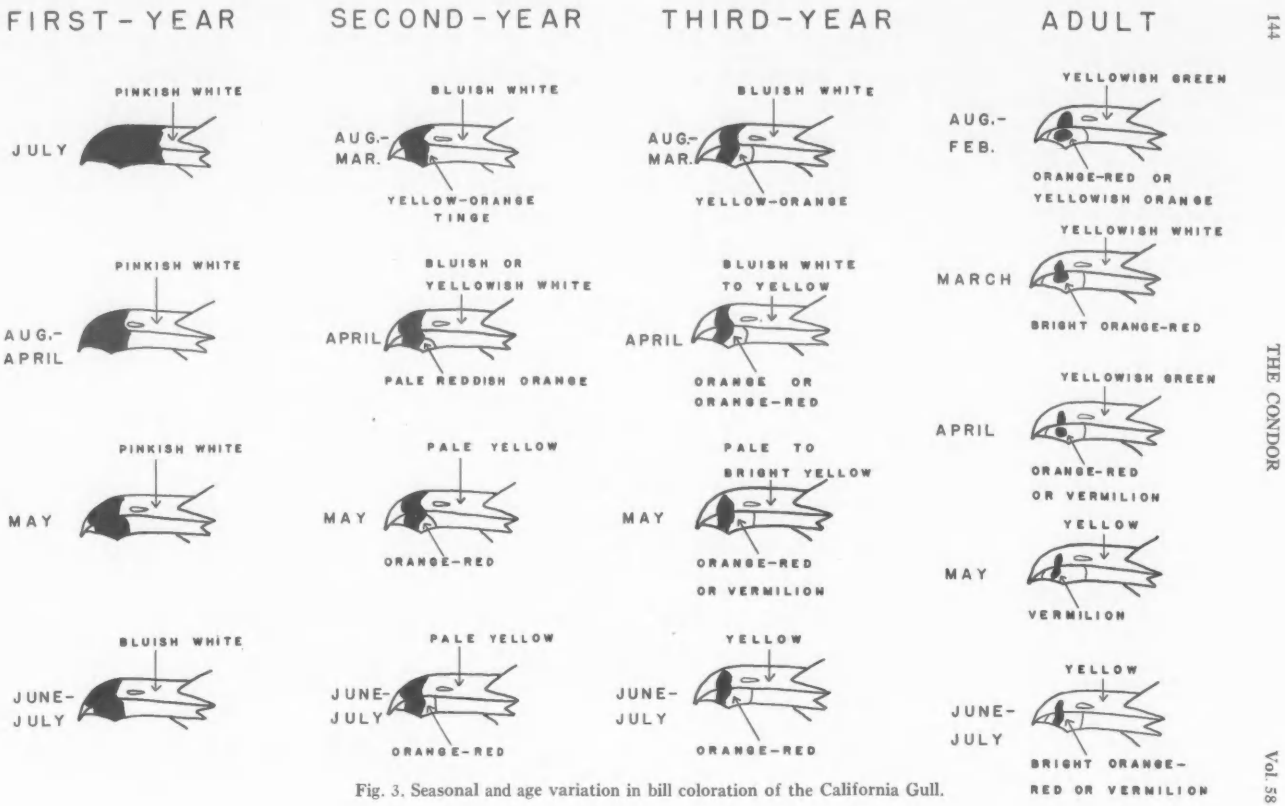

Fig. 3. Seasonal and age variation in bill coloration of the California Gull.

that was basally pinkish white, but more than one-half of the terminal portion was blackish. Changes subsequent to these initial colors are indicated in figure 3.

It has been conclusively demonstrated that bill coloration in some species of birds is under the control of male sex hormones. Significant among the studies conducted on androgenic control was that of Keck (1933) on the English Sparrow (*Passer domesticus*). He demonstrated that the bill of the male changed from horn brown or ivory in the nonbreeding season to black in the breeding season under the influence of male sex hormones. These results have been corroborated by Witschi and Woods (1936) in a more intensive investigation of the histological picture of melanophore dispersal and development. The change in bill color to black coincided with the development of the testes to a maximum breeding condition. Further work on feral English Sparrows by Davis (1953) has shown that at least some birds-of-the-year (3 out of about 100) in June and July not only had testes in breeding condition but also black bills, both characters the same as in breeding adults taken at the same time. In view of the experimental results of Keck and Witchi and Woods, it would seem that these few juveniles were producing enough androgens to evoke a change in the bill color.

In the British Starling, Bullough (1942, figs. 13–36, p. 197) has drawn and described seasonal changes in the bills of adult males and females. From about June through November, the bills of both sexes are predominantly dark gray, but they become progressively yellower in the breeding months, especially in February and March. Juveniles and first-year birds have dark bills until February at which time yellow color develops, again coincident with gonadal recrudescence. This change in color from gray to yellow was attributed to the production of the male hormone by the testis. Witchi and Miller (1938:468) have demonstrated that the bills of both sexes in captive birds turn yellow under the influence of androgens but do not react to estrogens.

In the Herring Gull (*Larus argentatus*), a close relative of the California Gull, there is further evidence (Boss, 1943) that bill coloration is under androgenic control. Poor (1946) reported on banded Herring Gulls in which colors of soft parts, in addition to other characters, were given for individuals of known ages. The matter of seasonal bill coloration was summarized for this species and is generally simliar to that in the California Gull. If this work of Poor on birds of known age and the work of Dwight (*op. cit.*:180–197) based upon molting and nonmolting birds are considered as natural background, comparison may then be made with the results of hormonal investigations conducted by Boss. He injected testosterone, stilbestrol, thyroxin and gonadotropin into different groups of nestling birds. The testosterone-treated birds of both sexes matured in one year, but controls and birds injected with the other hormones required the full three years to acquire the mature plumage, behavior, and colors of soft parts. In experimentals the bill changed from all black to the adult type, yellow with a red spot. It would seem, then, that bill coloration is directly under androgenic control in both sexes.

Similarly, in the Black-headed Gull (*Larus ridibundus*) van Oordt and Junge (1933) have shown that the bill becomes crimson during the breeding season but is flesh-colored in the nonbreeding months. Castrated birds developed the crimson color when injected with male hormone.

In view of all these experimental results, particularly those on the closely related gulls, it seems safe to conclude that this character in the California Gull is also under androgenic control.

Leg.—Previous workers have indicated that the colors of legs and feet are the same, but experience with fresh California Gulls indicates that this is not always true. In many instances the color of the feet differs widely from the color of the tarsometatarsal region, which is somewhat variable in itself. In an attempt to reduce the numbers of

variables, therefore, only the predominant color or colors of the tarsometatarsus were recorded. Whether or not the legs were recorded as greenish yellow, yellowish green, grayish green or greenish buff (all color combinations of various breeding adults), the facts remain that yellow and green predominated in adults, that many third-year birds' legs were practically indistinguishable from those of adults, and that all first- and second-year birds were entirely different from adults.

In table 4, trends of leg colors are indicated for all age groups. It is of interest to note that there is a rough correlation between the color of the base of the bill and the color of the legs. This becomes apparent when one compares the data in figure 3 on bill colors with table 4 on leg colors.

Table 4

Seasonal and Age Variation in Leg Coloration

First-year		Second-year		Third-year		Adult	
July	blackish brown	Aug.-April	bluish white or pale greenish			Aug.-Dec.	bluish or yellowish green
Aug.-Feb.	pinkish white or brown			Aug.-Feb.	bluish white or green	Jan.-Feb.	greenish buff
Mar.-May	bluish white with pink tinge			Mar.-April	pale bluish green	Mar.-April	greenish buff or yellow
June-July	light greenish blue or bluish white	May-July	bluish green or pale yellowish green	May-July	pale bluish green or greenish yellow	May-July	yellowish green, yellow, or greenish yellow

Eyelid.—A summary of eyelid coloration by seasons and ages is presented in table 5.

Gape.—In a fashion similar to the color of the eyelid, the color of the gape varied seasonally and with age; a summary of the typical or usual color is given in table 6. By comparing these data with the tables for eyelid color and pigmentation of the bill, a general correlation becomes apparent. For example, adults in May have a vermilion gape, eyelid, and spot on the lower mandible.

In the Purple Finch (*Carpodacus purpureus*), Magee (1943) has shown by using birds over a period of years that in males the color of the gape changes from dull brownish in winter to bright red-orange at about the height of the breeding season. Sexual dimorphism was noticed in manifestation of this seasonal color; first-year males had red gapes but females did not.

Although somewhat less direct evidence is available than for the bill, probably the colors of the leg, eyelid and gape are also under androgenic control. Boss (1943) did not specifically discuss these structures as he did bill color and plumage characters, but, by stating that birds became mature in one year under testosterone injections, he indicated that these soft parts also attained the adult or mature colors. If vermilion may be considered as the ultimate or mature color attained by the eyelid and gape, adults reach this color seasonally (March or April) before third-year birds (May) and retain it much longer than do the third-year birds. This attainment and retention of the brighter coloration is probably correlated with androgenic titers.

Table 5

Seasonal and Age Variation in Eyelid Coloration

First-year	Second-year	Third-year	Adult
blackish brown	blackish brown	Aug.-Feb. yellow-orange or blackish brown	Aug. orange-red or brownish orange
			Sept.-Feb. dark red or orange-red
	April yellow-orange to reddish orange	Mar.-April- dull orange-red or orange	Mar. orange-red or vermilion
	May orange-red	May orange-red or vermilion	April-June vermilion
	June-July red or orange-red	June-July red or orange-red	July red or orange-red

Table 6

Seasonal and Age Variation in Gape Coloration

First-year	Second-year	Third-year	Adult
Aug. flesh-colored	Aug.-Sept. flesh-colored or orange-yellow	Aug.-Mar. orange or yellow-orange	Aug.-Mar. orange-red
	Oct.-Mar. yellow-brown or orange		
	April yellow-orange or reddish orange	April orange-red	April-May vermilion
May-June flesh-colored or dull orange	May orange-red	May vermilion	
July flesh-colored	June-July orange-red or yellow-orange	June-July vermilion or dull orange-red	June-July vermilion or bright orange-red

BURSA OF FABRICIUS

The bursa of Fabricius has been used rather extensively to determine the age of birds, particularly certain species of game birds. The bursa is prominent at an early age and generally disappears upon attainment of maturity of the bird (Hochbaum, 1942; Elder, 1946; Leopold, MS). The exact function of the bursa is not known, even though various workers have investigated the anatomy and physiology of this structure (see Linduska, 1943:427, for a discussion of this subject).

In the California Gull, measurements of the bursa were taken on most of the birds collected except for a period from July through September. The measurements were made by placing a millimetric rule against the outside of the bursa on the inside of the peritoneal cavity; the greatest length from the wall of the cloaca to the tip of the bursa

was taken. The results of these measurements as correlated with age are presented in figure 4.

Although for a given month the bursae of first- and second-year birds might not be significantly different in length, the graph does show a general trend toward virtually complete atrophy of the structure by the time the gulls are in adult plumage. Certain

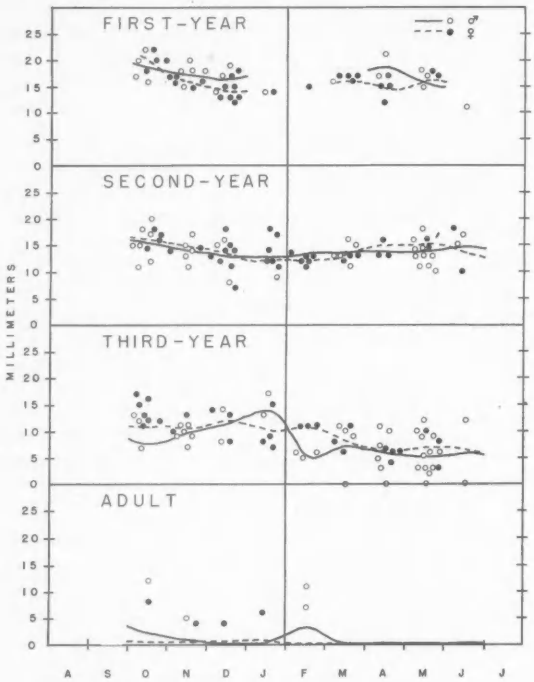

Fig. 4. Length of the bursa of Fabricius. Lines represent mean monthly values. Of 122 adults examined, only the 8 which had a bursa are plotted on the graph.

discrepancies arise in the third-year and adult groups, such as absence of the bursa in some third-year birds and its persistence in some adults. As a general rule it was found that third-year birds of both sexes that were believed to be breeding had smaller bursae than did the nonbreeding birds of this age group. Out of fourteen third-year birds (May, 1953), seven were believed to be breeding, and, with the exception of one bird with a 10 mm. bursa, all had bursae less than 6 mm. On the other hand, out of the seven nonbreeders all except two had bursae at least 8 mm. in length. Similarly, in the Canada Goose (*Branta canadensis*), Elder found that wide variation in the rate of bursal regression was an indication that geese do not all reach breeding condition at the same age. Probably the gulls in adult plumage that still retained a bursa were birds four or five years old, but, of course, it was not possible to determine the age of these birds after the third year.

Hormonal control of the bursa has been worked out in the Ring-necked Pheasant by Kirkpatrick and Andrews (1944). They concluded that in the male, testosterone is responsible for the involution of the bursa while in the female stilbestrol induced the same involution. Direct evidence of hormonal control is lacking for gulls, but, as will be discussed in detail later, there are several facts which indicate a greater androgen output in adults than subadults, especially during the breeding season.

TESTIS CYCLE

SIZE

A customary criterion for avian reproductive condition has been the degree of hypertrophy of the testes. This enlargement may be determined in a number of ways by measurement. Since the testes of both breeding and nonbreeding gulls were found to be ellipsoid in shape, volumetric determination derived from linear measurements was considered to be sufficiently accurate. The formula for the volume of an ellipsoid was used: $V = 4/3\ \pi ab^2$, where $a = \frac{1}{2}$ longest diameter and $b = \frac{1}{2}$ shortest diameter. In 222 birds both testes were measured immediately after the birds were shot in the field and before fixation; in a few instances when one testis was damaged by shot, only the undamaged testis was measured. In most previous studies only the left testis has been measured, and, from the results of measuring both testes of 222 California Gulls, this would seem to be a valid procedure (see table 7).

Table 7

Comparison Between Volumes of Left and Right Testes

	Number	Per cent
Left testis larger than the right	188	84.7
Right testis larger than the left	19	8.6
Testes equal in volume	15	6.7
	222	100.0

Riddle (1918) and Friedmann (1927) have considered the problem of testicular asymmetry in birds, and Riddle, working with pigeons, thought that an excess of males in a population was always correlated with proportionately larger left testes. Friedmann presents evidence from many species collected at random showing that this is not true of wild populations. The data for the California Gull support Friedmann's conclusion. As will be discussed in a later section, practically a 50–50 ratio of adult males and females was obtained at the Mono Lake colony and yet, as table 7 indicates, the greater percentage of males has the left testis larger than the right. Friedmann further indicates that in two species of the Laridae (both terns) the testes were equal in size, but he did not examine any *Larus*.

Cycle for migratory birds.—The graph of testicular enlargement for the California Gull is plotted on a semilogarithmic scale in figure 5. The range and number in each sample are given in table 8. Generally the mean volume of the left testis is larger than that of the right testis. For the critical months of April and May when the data were available, semimonthly means for third-year and adult birds have been calculated. These semimonthly divisions were considered to be desirable because in April the first half of the monthly sample includes premigratory birds from the San Francisco Bay area whereas the second half includes recent arrivals at the breeding colony at Mono Lake. The sample from the first half of May includes birds at a time just after most of the eggs in the colony had been laid, and the second-half sample is comprised of birds taken just before eggs hatched in early June.

Table 8

Testis Volume for All Monthly Samples

Age group	Month	Left			Right		
		Number	Range in mm.³	Mean	Number	Range in mm.³	Mean
First-year	August	10	2.1– 16.5	9.3	9	1.3– 10.5	7.3
	September	2	11.5	11.5	2	8.4– 11.4	9.9
	October	6	8.4– 10.5	9.4	5	6.3– 8.4	7.1
	November	4	8.4– 13.6	10.5	2	8.4– 10.5	9.5
	December	2	9.4– 10.5	10.0	2	5.9– 7.3	6.6
	January	3	6.3– 9.4	8.0	2	7.3– 13.1	10.2
	February	0			0		
	March	2	8.4– 10.5	9.5	2	4.1– 8.4	6.3
	April	1	16.4		1	16.4	
	May	5	10.5– 28.3	16.6	5	5.3– 13.1	9.3
	June	0			0		
	July	1	9.4		1	8.4	
Second-year	August	4	8.4– 23.6	17.2	4	6.3– 10.5	8.7
	September	5	8.4– 19.8	13.1	5	1.6– 8.4	5.9
	October	7	8.4– 28.3	15.2	7	6.3– 18.9	11.6
	November	5	9.4– 16.4	12.1	5	5.3– 14.7	9.4
	December	2	14.7– 26.0	20.4	3	8.4– 10.5	9.8
	January	2	4.7– 16.4	10.6	2	3.5– 13.1	8.3
	February	1	8.4		1	3.5	
	March	5	18.9– 50.4	28.5	5	11.4– 35.2	21.4
	April	0			0		
	May	5	85.1–1157.2	719.6	5	54.4–1013.7	569.0
		4	28.3– 419.2	262.7	3	26.0– 256.6	129.1
	June	3	207.9– 385.6	292.0	3	104.8– 189.0	144.6
	July	0			0		
Third-year	August	4	11.5– 30.7	19.5	4	9.4– 16.3	12.3
	September	7	8.4– 104.8	33.5	7	8.4– 33.2	13.9
	October	6	9.4– 26.0	13.1	6	6.3– 23.6	12.6
	November	5	8.4– 38.5	22.8	5	7.3– 23.6	13.5
	December	1	18.0		1	9.4	
	January	2	19.8– 23.6	21.7	2	7.3– 9.4	8.4
	February	3	19.8– 32.1	26.7	3	9.4– 18.9	14.9
	March	4	32.1– 54.4	42.5	4	21.2– 38.5	31.1
	April	3	38.5– 244.8	112.6	3	54.4– 118.1	75.6
		3	402.2–2053.1	1198.7	3	282.4–1204.5	774.8
	May	7	806.0–2258.9	1321.8	7	502.9–2156.0	956.1
		6	502.9–1140.7	796.8	4	486.4– 890.0	675.0
	June	7	282.4– 714.8	470.3	7	117.9– 636.5	330.2
	July	6	90.2– 594.0	252.1	6	58.7– 308.0	140.3
Adult	August	7	48.1– 158.4	96.9	7	32.1– 141.4	67.2
	September	4	58.7– 67.0	63.0	4	28.3– 46.0	37.4
	October	5	23.6– 41.7	29.1	5	21.2– 50.4	29.4
	November	5	16.4– 102.9	57.4	5	16.4– 50.4	32.8
	December	5	46.0– 111.4	71.7	5	38.5– 91.8	57.3
	January	3	78.8– 150.9	102.8	3	58.7– 91.8	78.5
	February	5	26.0– 98.3	65.0	5	21.2– 79.5	42.5
	March	5	54.4– 680.0	309.2	5	71.2– 419.2	204.0
	April	2	256.6– 410.6	333.6	2	150.9– 282.4	216.7
		3	2357.3–3281.0	2743.7	3	1659.2–1770.6	1703.8
	May	10	942.8–2882.6	2007.7	9	1013.7–2053.1	1568.2
		5	295.4– 785.0	463.9	5	131.0– 550.8	351.3
	June	12	67.0– 321.0	160.3	12	78.6– 254.5	119.0
	July	9	58.7– 368.8	135.3	9	38.5– 134.7	83.1

During the first year there is no noticeable increase in size of the testes until about the middle of May at which time there is a small increase. This enlargement might have occurred in April, but not enough data are available for that month. This increase is not correlated alone with the breeding season because this slightly greater testis volume is maintained at approximately this same level (between 10 and 20 mm.^{3}) during the second winter.

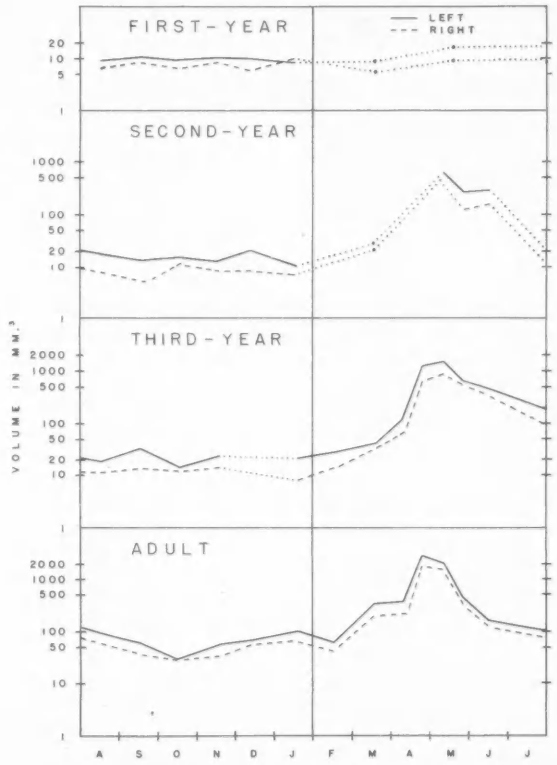

Fig. 5. Semilogarithmic graph of cycle of mean testis volume. Dotted lines represent suspected trends when a monthly mean was not available.

Beginning in late February, or more likely early March, second-year birds show a noticeable increase in testis size. Although no sample of second-year birds was obtained in April, apparently birds in the middle of May at the breeding colony reach the greatest testis size for this age group. At this time adults already had eggs in their nests (see fig. 1). It will be seen that these second-year birds reach a maximum testis volume somewhat later than adult birds, and they involute rapidly until the winter minimum size is reached by August when the birds have returned to the San Francisco Bay area. This mimimum size may be reached in July, but no data are available for that month.

During May second-year birds show a very wide variation in testis volume, from 28.3 to 1357.2 mm.^{3} (left) and 26.0 to 1013.7 (right). This wide variation (see table 8) is believed to be correlated with different degrees of maturation even within a given age group. There is no evidence that any first- or second-year birds breed.

The winter monthly averages of testes for birds in their third year are somewhat higher than for birds in the second year. At the end of February and the beginning of March, there is another rapid increase in testis volume, but, on the average, third-year birds' testes are about twice as large as the testes of second-year birds in the first part of May. It is of considerable importance to point out that there is about a ten-fold increase in testis volume between premigratory and migratory birds of this and the adult age group in April, and that the maximum testis size for the third-year birds is found in the first half of May, somewhat later than in adults. As will be discussed in more detail later, some third-year males breed, and in five cases out of seven the testes of such breeding birds were larger than those of nonbreeders at the colony. Size of the testis, however, is not the only factor to be considered because all of these birds, nonbreeders included, had spermatozoa in their testes. I believe that, on the average, subadult breeding occurs a little later than adult breeding, but there is little documentary evidence for this in the California Gull. This phenomenon is known to occur in some passerine birds (see, for example, Baldwin, 1953:334–337).

After involution of the testis, the minimum winter size in adults is reached in October. Adult testes are season-for-season larger than testes of any of the other age groups. Following the spring enlargement, which begins at least by mid-February, the maximum size is apparently reached at the end of April (or perhaps the first week or so in May), a size which is larger than the average for third-year birds at the same time, but there is still an overlap in measurements between these two age groups. Adult testes begin to involute immediately after the eggs are laid in early May, since smaller testes are recorded for mid-May.

The general seasonal picture of testicular enlargement for this gull is similar to those reported for other species of birds. In both the first-year Starling (Bullough, 1942) and the Fulmar (Marshall, 1949) the maximum testis size in spring is smaller than that for adults. The sharp peak of enlargement in the gull is correlated with the single brood raised, whereas in passerine birds which are known to be at least double-brooded (for example, English Sparrow, Keck, 1934) a plateau of testis size is maintained for two or more months.

Rollin (1944) presents some figures for winter testis size in *Larus argentatus, Larus canus* and *Larus ridibundus*. During a period from November to February adult testes were one-half again as large as those in first-year birds. A few second-year birds had testes intermediate between these two age groups. The left testis was almost always larger than the right. The greatest difference in size between left and right testes was found in adult birds, whereas in first-year birds there was a smaller difference between the two testes. All these data are in agreement with the results of testis size presented in figure 5 for the California Gull.

Cycle for nonmigratory birds.—Due to the general scarcity of California Gulls along the Pacific coast during the breeding season, only a small sample of nonmigratory birds was obtained. There is a tendency for these nonmigrants to be widely dispersed, with less tendency for flocking and attraction to the local garbage dumps. A total of fifteen nonmigratory males was collected in the San Francisco Bay area in the seasons of 1952 and 1953, and the volumes of the testes of these birds are presented in table 9. By comparing this rather small sample with the data from birds which migrated to the breeding grounds (fig. 5 and table 8), it is seen that the volumes for first-year birds are probably

not significantly different, although only one bird was available for June and July at the breeding colony. At this time the testis volumes of nonmigrants indicate an increase similar to the sample in May of migratory first-year birds, and this volume is maintained as the approximate winter average for second-year birds.

Table 9

Testis Volume of Nonmigratory Birds

Date	First-year Left	First-year Right	Second-year Left	Second-year Right	Third-year Left	Third-year Right	Adult Left	Adult Right
May 6, 1953			67.0	54.4				
June 4, 1952	9.4	8.4	79.5	32.1				
	23.6	12.6						
June 26, 1952	10.5	6.3	16.4	8.4				
	10.5	18.9						
July 5, 1953	16.4	18.9						
	8.4	9.4						
	8.4	6.3						
July 21, 1952			28.3	8.4	21.2	23.6		
July 30, 1952	18.0	10.5					67.0	51.3
	8.4	7.3						

The testis volumes of nonmigratory second-year, third-year and adult birds during May, June and July are all significantly smaller than volumes for migratory individuals. With the data available it is difficult to explain why some individuals in the same age groups should develop large testes and migrate to the breeding colony while others remain in an undeveloped state and do not migrate. This would suggest a different response to the photoperiod by the pituitary-gonad mechanism which is associated with migration. At some point in this chain of events, certain individuals do not respond, but at what point and for what reason has not been ascertained.

Random collecting at the Great Salt Lake and Mono Lake colonies shows that there is a greater tendency for the older age groups to return to the breeding colonies than for the younger birds to do so, and most of the subadults which do return do not breed. Table 10 shows the numbers of each sex and age collected at these two colonies (data from Great Salt Lake from Behle and Selander, 1953:257). Furthermore, the information for nonmigrants is in agreement, because progressively fewer older birds were taken in the San Francisco Bay area during the breeding season.

Table 10

Numbers of Birds Collected During the Breeding Season

	Great Salt Lake Males	Great Salt Lake Females	Mono Lake Males	Mono Lake Females
First-year	3	0	6	4
Second-year	41	19	12	5
Third-year	43	4	29	4
Adult	19	18	40	38

Young Herring Gulls banded by Gross (1940) at Kent Island were obtained there again at all ages: first-year, 1; second-year, 6; third-year, 7; and adults, 28. A significant point which correlates well with observations at Mono Lake is the fact that (p. 147) "a few individuals in the first nuptial plumage are also to be seen at the colony during the breeding season. However, the breeding gulls discourage the presence of these younger birds and it is not an uncommon experience to see these dusky visitors violently driven away from the nesting area."

As Behle and Selander concluded, these data also indicate that in the subadult groups males are more numerous at the breeding colony than are females. The cause for this is not known, but it is probable that males tend to mature earlier than females. Further evidence for this comes from observations of subadult breeding of certain males but not of females and from soft-part colors which are more like adults in third-year males than in females. There is no reason to believe that females are elsewhere in the region of the breeding colony because no groups or individuals of nonbreeding birds were ever observed anywhere in the vicinity of Mono Lake other than at the colony.

TUBULE SIZE

By determining the mean size of the seminiferous tubules, it has been possible to show that there is a direct correlation between size of the tubules and size of the testis. Sections from 177 left testes were examined and the mean diameter of 10 tubules selected at random was calculated. Only tubules that were cut in perfect transverse sections were measured with the ocular micrometer. Sometimes faulty fixation or some physical distortion of the tubules rendered the section and the slide unusable for this particular phase of the study; thus, all 222 males were not examined. When more than one bird of a given age group was available for the month, a mean of the measurements from the birds was determined.

Table 11

Mean Tubule Diameter in Millimeters

Age group	Month	Number of birds	Range	Mean	Age group	Month	Number of birds	Range	Mean
First-year	August	5	.045–.058	.053	Third-year	August	3	.042–.060	.051
	September	2	.050–.058	.054		September	7	.046–.063	.052
	October	5	.046–.053	.049		October	6	.042–.053	.045
	November	4	.035–.050	.045		November	5	.040–.050	.046
	December	2	.041–.051	.046		December	1	.054	
	March	2	.043–.051	.047		January	2	.048–.054	.051
	May	3	.064–.067	.066		February	3	.058–.063	.061
Second-year	August	3	.045–.053	.049		March	4	.069–.076	.071
	September	5	.043–.054	.049		April	5	.070–.194	.128
	October	7	.045–.051	.049		May	8	.149–.212	.177
	November	5	.043–.048	.045		June	2	.129	
	December	3	.047–.048	.048		July	3	.080–.121	.093
	January	1	.044		Adult	August	7	.048–.061	.055
	February	1	.044			September	4	.050–.055	.053
	March	5	.061–.072	.067		October	5	.048–.056	.052
	May	8	.069–.202	.145		November	5	.052–.062	.057
	June	1	.149			December	5	.048–.056	.051
						January	3	.054–.059	.057
						February	5	.053–.065	.060
						March	6	.069–.111	.083
						April	5	.125–.178	.144
						May	7	.072–.201	.136
						June	6	.066–.094	.076
						July	6	.061–.085	.069

Table 11 summarizes the data on tubule size, and it can be seen that the tubule diameters follow the same general enlargement as the testes (table 8). A more detailed analysis of this type was carried out by Blanchard and Erickson (1949:274) on the White-crowned Sparrow (*Zonotrichia leucophrys*). One would not expect a perfect correlation because there are other variable constituents of the testis-intertubular cells, blood vessels and tunica albuginea. Except for first-year birds the larger tubules are

found during the breeding season in all age groups, and the smaller tubules during the nonbreeding seasons.

Just as in testis size, tubules of second-year birds during the breeding season are enlarged but are not as large as those of third-year and adult birds. Also, the maximum tubule size of second-year and third-year birds occurs in mid-May, but adults reach their maximum size in late April. Although the data show a larger breeding tubule for third-year birds when compared with adults, these two age groups probably are not significantly different. Similar results have been reported for the White-crowned Sparrow (Blanchard, 1941:57) and British Starling (Bullough, 1942:177).

HISTOLOGICAL STAGES OF SPERMATOGENESIS

At least one testis from each of 249 males was prepared for microscopic examination. After fixation in Bouin's fluid, dehydration was accomplished with dioxan. Paraffin sections were cut at 10 micra, and these were stained with Delafield's or iron hematoxylin and counter-stained with eosin. Only a small portion of the larger testes was sectioned, usually a part from one end.

The histological details of spermatogenesis have been worked out for several species of passerine and a few species of nonpasserine birds. Those passerine species which have been investigated include the English Sparrow (Loisel, 1900–1901), White-crowned Sparrow (Blanchard, 1941; Blanchard and Erickson, 1949), Starling (Bullough, 1942), Oregon Junco (Wolfson, 1942), and Red-winged Blackbird (Wright and Wright, 1944). In the broad features of spermatogenesis, all these species are in close agreement, although some differences of opinion have arisen relative to defining and delimiting the stages or steps which lead to the production of spermatozoa. The males of several of these species breed in their first and subsequent years, there being essentially no differences in spermatogenesis between first-year and adult birds. Many larger, nonpasserine species, however, such as the Fulmar (Marshall, 1949), do not breed until more than one year old, and the meager data for such subadults have indicated that their spermatogenesis might differ in some way from that of adults. On the other hand, the Ring-necked Pheasant (Hiatt and Fisher, 1947) and probably some other large nonpasserines mature and breed by the end of their first year; the breeding cycle of the first-year individual in these types is the same as that of the adult.

Several specific points regarding spermatogenesis in the California Gull need to be indicated. It has been necessary to describe anew the stages of spermatogenesis for this species because of its long maturation period, but these stages are roughly comparable to those used by Blanchard (1941). More stages, but relatively fewer details for each stage, are given for this gull so that it might be possible to determine more accurately exactly how far in spermatogenesis the subadults proceed before regressing. The interstitial cell cycle is not included with the spermatogenic cycle as other authors have done because the two cycles are not always "in phase" in a given month for any two age groups. For example, even at the height of the breeding season adults that have mature spermatozoa also have numbers of interstitial cells rated as "common" whereas third-year birds with spermatozoa have only "fairly common" interstitial cells. The interstitial cell cycle in adults, however, correlates closely with the spermatogenic cycle.

Stage 1: Inactive condition; primary spermatocytes (fig. 6*a*).—In the inactive winter condition the testes are at a minimum size, and the tunica albuginea is of maximum thickness. There is a basal row of spermatogonia and Sertoli cells next to the basement membrane. A small lumen is almost always present.

One of the most interesting characteristics of the inactive gull testis is the presence of primary spermatocytes in all sections examined. They lie for the most part toward the lumen from the spermatogonia and form a more or less complete row of cells, but occasionally they may be wedged between

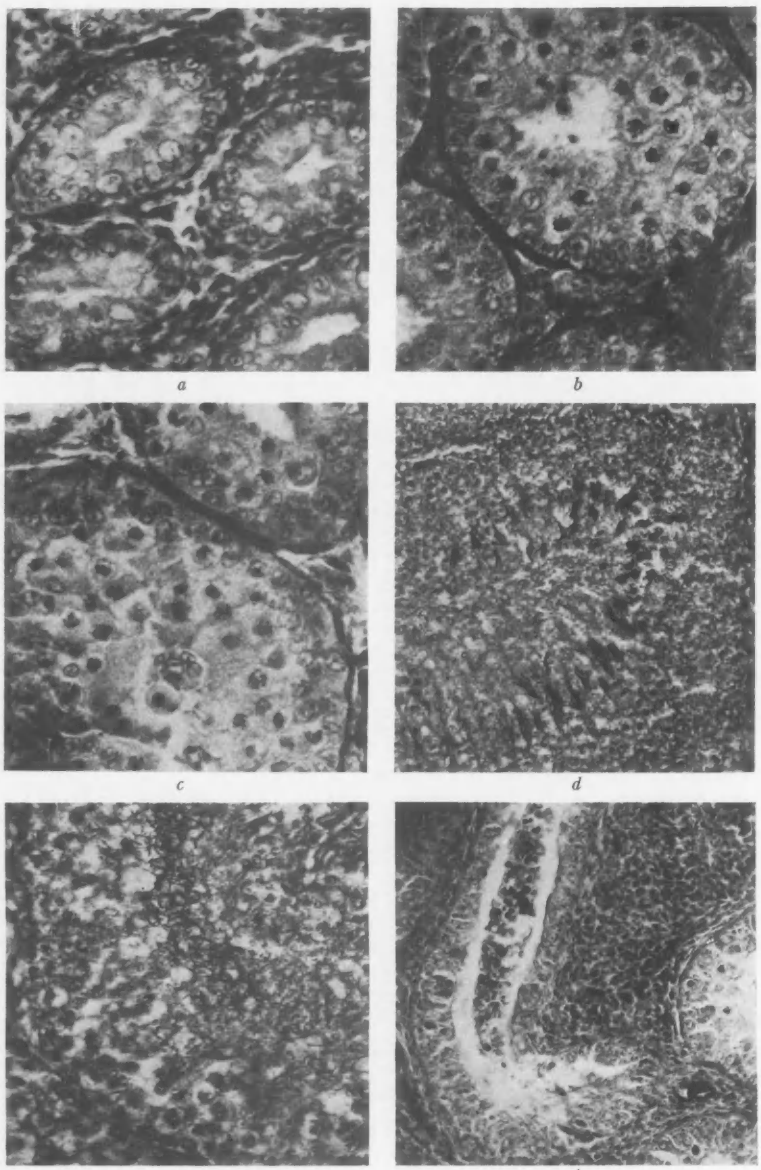

Fig. 6. Sections of testes of California Gulls showing representative histologic stages. *a*, stage 1, inactive condition; *b*, stage 3, primary spermatocytes in synapsis; *c*, stage 4, secondary spermatocytes; *d*, stage 6, breeding condition; *e*, stage 7, spermatozoa in lumen; *f*, stage 8, regression. *a-c*, approximately ×580; *d-f*, approximately ×270.

spermatogonia in the basal row. Probably these are the same cells that Loisel (1900–1901), Wolfson (1942) and other authors have described and figured as spermatogonia of the second order, but it seems more correct to call these cells inactive primary spermatocytes. Evidence to support this contention comes from at least two sources. In the first place, in the late summer and early fall when birds-of-the-year have primary spermatocytes in synapsis, it is noticeable that they are being derived from and pushed inward from the basal row of spermatogonia. In midwinter in this age group, when synapsis in the primary spermatocytes disappears, the size and position of the now-inactive cells are the same as for the primary spermatocytes in synapsis at an earlier time. In fact, they might be the same cells. In the second place, these inactive spermatocytes are of the same size, shape and position as primary spermatocytes in synapsis which appear at the advent of spermatogenesis in the early spring. Hiatt and Fisher (*op. cit.*) noted that Ring-necked Pheasants also have spermatogonia and primary spermatocytes at all times of the year. This stage is equivalent to stages 1, 2, and 3 of Blanchard.

Stage 2: Primary spermatocytes in synapsis.—There is still basically one row of spermatogonia and Sertoli cells, but there may be some increase in the number of these cells, especially if a long stage 1 (that is, of winter duration) preceded this stage. (Exception to this statement is to be found in first-year birds in the summer and early fall when their testes are of minimum size with no apparent increase in number of any cells; a short stage 1 would have preceded this condition.) Up to about one-half of the primary spermatocytes in a given cross section of a tubule have their chromosomes in synapsis, and frequently the chromosomes lie at one side of the nucleus. As in stage 1, these primary spermatocytes form an incomplete row of cells next to the lumen. The lumen is sometimes filled with detritus. Blanchard's stage 4 is an equivalent stage, except that the tubules in the gull are not noticeably larger than those of the preceding stage.

Stage 3: Increase of primary spermatocytes in synapsis (fig. 6*b*).—The tubules begin to enlarge, and the tunica albuginea becomes thinner as the entire testis enlarges. Primary spermatocytes in synapsis have increased in number to the extent that (1) the majority of them are in synapsis and (2) they usually form two or more rows next to the lumen, moving away from the basement membrane. This is similar to Blanchard's stage 5, except that testes with secondary spermatocytes are not included in this stage. Wolfson (1942:253) does not regard this as an adequately delimited stage, at least in the White-crowned Sparrow and Oregon Junco, but in gulls it was easily separable from stages 2 and 4, although one stage grades into another.

Stage 4: Secondary spermatocytes (fig. 6*c*).—The second part of Blanchard's stage 5 included the presence of secondary spermatocytes, but in the gull this stage may be recognized as distinct. Perhaps, in the White-crowned Sparrow, Blanchard should have recognized a separate stage for secondary spermatocytes because between her stage 5 (predominance of primary spermatocytes in synapsis plus a few secondary spermatocytes) and stage 6 (spermatids) there was an unaccountable gap in testis volume between 13.0 and 19.7 mm.[3] This stage and the following are not as frequent as the other stages in gulls, but this is probably because they are of shorter duration.

Stage 5: Spermatids.—Most of the spermatids border the lumen, but a few metamorphosing ones are seen moving away from the lumen toward the Sertoli cells. Only rarely are mature spermatozoa present, these being in negligible numbers. Spermatids are in relatively small numbers when compared to the number of primary spermatocytes. This was even true in testes in stage 6. This condition stands in marked contrast to the testes of some passerine species in which spermatids may occur in several rows bordering the lumen (see, for example, White-crowned Sparrow, plate 11 of Blanchard, 1941). Since only a few birds were found in this stage, it is probable that not only is the stage passed through rapidly but also that sampling of migratory and premigratory birds at the correct time was inadequate.

Stage 6: Spermatozoa in bundles: breeding condition (fig. 6*d*).—Testes and tubules are at maximum size in this and the next stage; also, the tunica is thinnest. Spermatozoa are present in a large number of bundles which are spaced around the tubule; they may be in several rows. Much cellular debris is present in the lumen. Only occasionally are the spermatozoa seen in the lumen, but evidently some quantity of them must have already passed down the reproductive ducts because birds with testes in this stage were seen in copulation at the breeding colony. Furthermore, by the time the ma-

jority of the adults reached the following stage (May 15), most of the eggs in the colony had already been laid.

Stage 7: Spermatozoa in tubular lumen (fig. 6*e*).—This stage differs from stage 6 because here the majority of the sperm bundles have been shed into the lumen of the tubule. Much detritus is also present in the lumen. This may be the beginning of regression because in some subadults the testis is beginning to decrease in size. Adult testes, however, reach their largest average size in this stage (table 8), and there is no noticeable collapse of the tubules. For these reasons stage 7 is regarded as a separate stage from regression.

Stage 8: Regression (fig. 6*f*).—Other authors have not always considered regression in a spermatogenic study, but in any treatment of an annual cycle of gonadal events, it must be taken into account. After the spermatozoa are shed into the lumen, this event is followed by the casting off, in succession, of spermatids, spermatocytes and probably spermatogonia and Sertoli cells. This entire phenomenon of regression is considered here as a single stage. Large masses of necrotic cells and cellular debris are found in the lumen, and the tubules collapse. At the same time, at least some spermatogenesis is still going on because primary spermatocytes in synapsis are evident. Toward the end of regression, only a few cells may be found in the lumen while a basal layer of spermatogonia, Sertoli cells and usually a few primary spermatocytes remain. It is likely that the primary spermatocytes which are found in the winter inactive testes are derived from spermatogonia at the end of regression. This is also the period when the collapsed tubules are becoming smaller, approaching the inactive winter condition.

Figure 7 summarizes the annual cycle of spermatogenesis for the four age groups. In approximately one-half of the gulls, both the right and left testes were examined, but, since no significant differences were found between the two testes, only the left testis was sectioned thereafter. There is a strong tendency for individuals of the same age on the same day to have testes in the same spermatogenic stage, especially in third-year and adult birds. Some of the second-year birds, however, are more variable, especially at the height of the breeding season.

Examination of the data for first-year birds in late summer and fall suggests that some spermatogenic activity is taking place at that time. The presence of primary spermatocytes in synapsis (stage 2) was a condition indistinguishable from that of testes at the advent of spermatogenesis in the spring. None of the other age groups showed this out-of-season spermatogenesis. A partly different condition of precocious sexual development has been reported for the English Sparrow in which species Davis (1953) found a few juveniles which were sexually mature in June and early July. This condition was attributed to the probable fact that these birds had been hatched in late winter and were subsequently brought into sexual activity by the pituitary responding to increasing day length. Some birds even had primary spermatocytes in September. The explanation for sparrows in June and early July is inappropriate for the first-year gulls because the latter were collected from August through October when the day length was shortening. A situation suggesting spermatogenic activity similar to that in the first-year gull has been noted in juvenal Ring-necked Pheasants by Hiatt and Fisher (1947:538–539). From September 15 to October 7, all the birds-of-the-year examined by them were in an advanced stage of spermatogenesis, and three birds even had spermatozoa.

Although only a small sample of first-year males was taken at the Mono Lake colony during the breeding season, all the evidence points to the fact that birds of this age group which return to the breeding colony never have testes beyond stage 3. Similarly, first-year male British Starlings were found by Bullough (1942:178) to have only primary spermatocytes in synapsis during the breeding season. This incomplete spermatogenesis would provide an obvious reason for nonbreeding in this age group.

Spermatogenesis in second-year birds at the breeding colony was somewhat intermediate between that of the nonbreeding first-year birds and the breeding adults. As has been mentioned previously, there is no evidence that any second-year birds in this

species ever breed, but the fact that many such birds are at the breeding colony with spermatozoa in their testes presents a peculiar situation. These would be potentially breeding birds, but I believe this gonadal condition is the only known feature of this age group which may be considered mature. Birds of this age with their browner plumage and less bright soft parts must be recognizable as such to adults, and it is probable

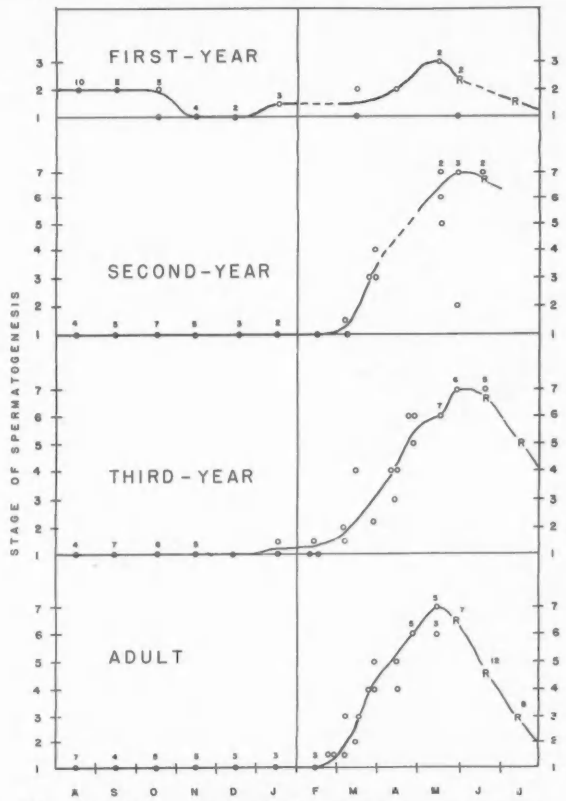

Fig. 7. Cycle of spermatogenesis. The solid line represents a mean value, and the broken line a suggested trend when data were not available. Regression is indicated by "R."

that they are not accepted as mates because of these differences. On several occasions at the Mono Lake colony, second-year birds were seen to alight amid the eggs and young of adults, but they were soon driven off by the nearby adults.

One might wonder, then, if the second-year birds interbreed, but again there is no evidence that this occurs in the California Gull. Although males of this age group might have spermatozoa, and are thus potential breeders, among the females it can be shown that the ovary is not yet producing enlarged follicles. In the Glaucous-winged Gull (*Larus glaucescens*), Jones (*fide* Bent, 1947:67) observed that some immature birds of unknown age were breeding apart from the main colony of breeding adults.

There were two puzzling second-year males (fig. 7) which, during May at Mono Lake, were in incomplete stages of spermatogenesis (stages 2 and 5). In the same age group, why should some birds be so much more advanced in spermatogenesis than others? The answer to this question seems to be that even in one age group there are degrees of maturity. Some second-year birds also approach the adult characters of plumage and colors of soft parts more than others. These degrees of maturity are probably also reflected in sex hormonal titers.

The spermatogenic cycles for the third-year birds and adults are essentially the same except that there seems to be a tendency for the adults to begin regression sooner. A possible explanation for this might be that the few third-year males which breed do so a little later on the average than do the adults. This is also indicated by the fact that adults on the average reach a given stage of spermatogenesis even away from the breeding colony before the third-year birds. Apparently, most, if not all, of the third-year birds and adults completed spermatogenesis. At least, no birds were taken during May and June which were not in stage 6 or 7 or regressing from these.

Even though it was not possible to follow and collect birds all the way from the coast to the breeding grounds in the spring, it can be shown that adults reach at least stage 5 before arriving at the breeding colony, and it is possible that at least some birds have spermatozoa when they arrive. This is shown by the fact that all adults taken at the end of April had spermatozoa even though some birds were still migrating into the Mono Lake area. On the other hand, third-year birds prior to reaching the breeding colony were in stage 4, and at least one bird after arriving at the colony did not have spermatozoa. In certain passerine species (for example, Oregon Junco and White-crowned Sparrow) birds at the onset of migration have less developed spermatogenic stages than does the California Gull.

Although there is a general correlation between size or volume of the testis and stage of spermatogenesis in some species of birds, in the gull sufficient overlapping of stages in one age group and variations in volume in the same stage from one age group to another occur to make inaccurate the use of size of testis as an indicator of spermatogenesis.

Nonmigratory males.—Nine first-year birds were taken in June and early July (see table 9), and, with the exception of one bird in stage 3 and beginning to regress, all were in stage 1. A second-year bird on May 6, 1953, was in stage 5, and three others in this age group in June and July were in stage 8. Only one each of a nonmigratory third-year and adult bird was taken; these were obtained in late July when regression was nearly complete. No spermatozoa were seen in any of these testes.

These few records cannot be used as conclusive evidence in relating spermatogenesis to migration, but certain inferences might be drawn. As far as the first- and, perhaps, second-year birds are concerned, there does not seem to be a significant difference in spermatogenesis between nonmigratory and migratory individuals. In regard to first-year birds, I cannot agree with Behle and Selander (1953:246) that "perhaps the lack of development of the gonads is correlated with poor development of the migratory instinct. . . ." The first-year birds which they collected, and also the ones in the present study had poorly developed gonads and yet had migrated to the breeding colony. Apparently some factor or factors other than the mere development of the gonads are more closely related to migration in these first-year birds.

[Part II dealing with the other aspects of the reproductive cycle and a summary will appear in The Condor in a later issue.]

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Museum of Vertebrate Zoology, Berkeley, California, August 1, 1955.

FROM FIELD AND STUDY

An Ancient Murrelet in Northeastern Nevada.—On the morning of November 14, 1955, following the first major winter storm of the season, Frank Lespade found an Ancient Murrelet (*Synthliboramphus antiquus*) in the yard of a local lumber dealer in Elko, Nevada. The live bird was turned over to George E. Gruell who in turn passed the bird on to me.

In view of the unlikelihood of this individual finding its way back to a marine environment from so far inland, it was made into a study skin (now no. 133834 Mus. Vert. Zool., Berkeley). The bird, a female, was lean and showed signs of diarrhea. This specimen not only constitutes the first record for this species in Nevada, but apparently it also represents the first Nevada record for any member of the family Alcidae. Later, it was learned that Mike Coboz, an associate of Lespade, saw another bird of apparently the same species on the Humboldt River in Elko on this same day.

One can only speculate how a normally short-flighted, strictly oceanic species could wander so far inland. Bent (U. S. Nat. Mus. Bull. 107, 1919:138–140) notes that the flight of this species is "swift and direct, usually close to the surface of the water, and not usually much prolonged." He continues: "I have never seen this species make a long flight." The murrelets that appeared in Elko would have had to make a sustained flight of at least 175 miles from the nearest large body of fresh water (Pyramid Lake, in western Nevada), or one of nearly 475 miles from the nearest seacoast of northern California, crossing mountain ranges exceeding 5000 feet elevation en route.

The possibility that the storm of November 13 might have carried these birds so far inland makes it worthwhile to record some details of this storm. On November 11, there was a strong low pressure area centered in northwestern Colorado, and a strong high pressure area centered about 600 miles off the Washington coast. The gradient between the two pressure centers was steep enough that an air mass moved almost directly to the east, accompanied by winds with velocities of 20 to 39 knots at lower levels. This rapid movement of air brought moderately heavy precipitation in the form of snow to much of northern Nevada, and perhaps it also carried a flock of lost Ancient Murrelets along with it.

Perhaps significant is the recent record by Jewett (Condor, 53, 1951:301) of a female of this species east of the Cascades in central Oregon, also in mid-November (1950) and following a heavy cyclonic storm with high winds. If the Nevada birds were diverted while on southerly migration from their Alaskan nesting grounds, one would expect them to be gradually pushed inland as they moved south, coming over the same area from which Jewett reported his bird, rather than being blown directly east from the northern California coast.—Gordon W. Gullion, *Elko, Nevada, November 21, 1955.*

Prolonged Incubation by an Anna Hummingbird.—On June 27, 1955, a female Anna Hummingbird (*Calypte anna*) started building a nest in the pendulous branches of a birch tree (*Betula alba*) at Alameda, California. The first egg was laid on July 3. On the following day the second egg was laid and she began incubating. The eggs did not hatch but she continued sitting through October 6, a total of 95 days. All during this time nothing seemed to disturb her. She sat as tightly as she had done in the beginning. I could approach within two feet of the nest before she would leave. Several times birds would perch within a foot of the nest and she would not move.

She continued to turn the eggs. At times she was seen bringing cobwebs and pappus of the achenes of *Gazania splendens* which she would poke into the nest. When she finally deserted the nest, I sent the eggs to Alden H. Miller who stated that they showed no signs of embryonic development. All that was left was dried yolk material as from a fresh egg. Presumably the eggs were infertile.—Junea W. Kelly, *Alameda, California, December 5, 1955.*

Another Record of the Tropical Kingbird for California.—On October 22, 1955, approximately three and a half miles northwest of Arcata, Humboldt County, California, a kingbird was observed flying and feeding from a barbed wire fence next to a pasture. Upon close examination, the notched tail was observed and the bird was collected. Comparison with specimens at the Museum of Vertebrate Zoology proved that the species was the Tropical Kingbird, *Tyrannus melancholicus*. The length of the wing (104 mm.) and tail (88 mm.) agree well with those of the race *T. m. occidentalis*. The sex of the bird was not determined but the frontal and parts of the parietal bones were still

single roofed, indicating that the specimen was an immature. The skull and wing are now in the collection at Humboldt State College.

This record is additional support for the assumption made by Cogswell (Condor, 54, 1952:117) that the northward movements of wandering vagrants of this species in the fall may be fairly commonplace, at least along the Pacific coast.—ROLF E. MALL, *Humboldt State College, Arcata, California, November 29, 1955.*

A Fossil Magpie from the Pleistocene of Texas.—A nearly complete left tarsometatarsus of a magpie is included among fossil vertebrate material from the panhandle of Texas under study by Dr. Donald E. Savage. We are indebted to Dr. Savage for opportunity to report on this specimen. The bone (Univ. Calif. Mus. Paleo. no. 43386) comes from Palo Duro Falls (locality no. V–5318, Univ. Calif. Mus. Paleo.), Randall County, Texas; more precisely this is 9 miles east and 3½ miles north of Canyon along the graded road leading from the old "Harding Ranch" house out over the south wall of Palo Duro Canyon. The bone was associated with mollusks, turtle and fish fragments, and a few small mammal bones in a stream channel sand that is part of a larger alluvial channel in the Caliche (limey) caprock of the Texas panhandle plains. On the basis of combined, although meager, paleontologic and geologic evidence, Dr. Savage states that the age of the vertebrate remains here is probably post-Blancan or, in other words, early Pleistocene. It is definitely not older than Blancan and it is possibly, although less likely, as late as mid-Pleistocene.

The fossil tarsometatarsus shows its identity with the genus *Pica* among the Corvidae most clearly by the configuration of the shaft (see fig.) which is almost parallel-sided throughout its length, involving a distinct narrowing just distal to the scar of the M. tibialis anticus, and by the less rounded outline of the medial cotyla in contrast with other corvids of similar dimension. New World corvids which bear near resemblance in size of the tarsometatarsus to *Pica* are *Calocitta, Psilorhinus,* and *Cyanocorax. Calocitta* and *Psilorhinus* are shorter and relatively stouter, with the proximal end of the shaft stouter than the distal end. *Cyanocorax* is the same length as *P. pica* but shows more taper in the shaft and a distinctly more rounded medial cotyla.

The two Recent forms of North American magpies, *P. pica hudsonica* and *P. nuttallii,* show overlap in all measurements of the tarsometatarsi (see table). Even though *P. p. hudsonica* and *P. nuttallii* exhibit a similar size range in total length of the tarsometatarsus, *P. nuttallii* is still a relatively smaller bird and this difference is reflected in a reduction of the massiveness of the cotylar and trochlear ends. Statistical significance can be demonstrated (see table of *t,* Simpson and Roe, Quantitative Zoology, 1939:206) in the differences between the means of the measurements of *P. nuttallii* for trochlear width ($P<.01$), cotylar width ($P<.05$), and anteroposterior length of medial cotyla ($P<.01$) and those of the fossil. The fossil falls within or barely exceeds the upper size limits of *P. p. hudsonica* and *P. p. japonica,* whereas it greatly exceeds the extremes of *P. nuttallii* in the three measurements. It is therefore identified as *Pica pica.*

In North America, fossil magpies (*P. nuttallii*) heretofore were known only from the late Pleistocene of California (A. H. Miller, Univ. Calif. Publ. Bull. Dept. Geol. Sci., 1929, 19:7; Wetmore, Smithsonian Misc. Coll., 131, 1956:92). The genus *Pica* has generally been considered to be of Old World origin and to have reached the North American continent "relatively recently," presumably via a Bering land bridge (Amadon, Amer. Mus. Novit. No. 1251, 1944:12). The magpie from Palo Duro Falls therefore places the time of arrival of the genus *Pica* in North America earlier than had previously been supposed.

Of significance is the fact that this early Pleistocene magpie represents the holarctic species *P. pica* rather than *P. nuttallii* whose range is at present restricted to California west of the Sierra Nevada. It is even possible that *P. nuttallii* could have been derived from *P. pica* at some time earlier

Measurements of Tarsometatarsi of Recent and Fossil Magpies

Species	No.	Total length		Trochlear width		Cotylar width		Anteroposterior length of medial cotyla	
		Mean and extremes	SD	Mean and extremes	SD	Mean and extremes	SD	Mean and extremes	SD
P. nuttallii	10	48.3		4.6		6.4		3.9	
		(45.5–50.2)	1.51	(4.2–4.8)	0.20	(6.1–6.7)	0.22	(3.6–4.2)	0.17
P. p. hudsonica	10	46.5		4.6		6.2		4.5	
		(44.5–48.0)	1.44	(4.4–5.2)	0.24	(5.7–6.9)	0.33	(3.9–4.6)	0.20
P. p. japonica	1	50.9		5.3		7.0		4.7	
Palo Duro Falls specimen	1	50.3		5.4		7.0		4.8	

than the Pleistocene. *Nuttallii* probably became isolated in western California as a derivative of *P. pica* of the Great Basin or northern plains and this could have occurred at the time of elevation of the Sierra Nevada in the Pliocene (A. H. Miller, Univ. Calif. Publ. Zool., 50, 1951:610).—ALDEN H. MILLER and ROBERT I. BOWMAN, *Museum of Vertebrate Zoology, Berkeley, California, August 20, 1955.*

Interspecific Relations between Goshawks and Ravens.—On October 6 and 7, 1955, in the Copper River region of south-central Alaska, four encounters between Goshawks (*Accipiter gentilis*) and Ravens (*Corvus corax*) were witnessed. During the late morning of October 6 at Mile 158 on the Richardson Highway, a Raven and an immature Goshawk were seen circling in close proximity 40 feet overhead. Intermittently, one of the birds would dip slightly toward the other, which would then exhibit a mild avoidance reaction and return the action. Overt aggressiveness or active chasing were not witnessed on the part of either bird and there was no vocalization. Approximately five minutes elapsed before the birds parted, soaring from view over the trees. Later the same morning at Mile 151 a Raven flew low over the highway with an adult Goshawk following a few feet behind and to the side. Neither bird was flying rapidly, but both veered sharply and returned over the timber when the observers came into view below.

On October 7, two additional encounters were seen, the first during the early morning at Mile 141 on the Richardson Highway. On this occasion the birds appeared quite suddenly, flying rapidly 15 feet over the trees with an adult Goshawk in definite pursuit of the Raven. After a chase of approximately 50 yards, the hawk closed the short gap and the Raven turned, beating its wings, and uttered a series of loud guttural notes. The Goshawk turned sharply, and both birds flew from view in opposite directions. During the early afternoon at Mile 119 on the same highway, an adult Goshawk flew low over the road followed closely by a Raven. Both birds promptly disappeared among the trees.

These two large diurnal birds, one a raptor and the other at least partly so, are widespread and abundant in this region. Opportunities for contact between the two species would seem numerous and it is reasonable to assume that in some instances competitive situations might arise in relation to food. However, with one exception, the incidents witnessed were not of an aggressive nature.—FRANCIS S. L. WILLIAMSON and ROBERT RAUSCH, *Arctic Health Research Center, United States Public Health Service, Anchorage, Alaska, November 23, 1955.*

White-winged Scoter in Texas.—The winter range of the White-winged Scoter (*Melanitta fusca*) is principally along the seacoasts, southward regularly along the Atlantic coast of North America to South Carolina and on the Pacific coast to Baja California. Bent (U. S. Nat. Mus. Bull. 130, 1925:142) mentions casual records from Colorado and Louisiana. On November 5, 1955, Mr. James Cullum of Wichita Falls, Texas, shot two birds of this species on Lake Kickapoo, Archer County, that seem to constitute the first record for the state of Texas. One specimen, an immature male, was presented to the Biology Department of Midwestern University and there preserved. It is noteworthy that the birds were taken in arid north-central Texas, where numerous artificial lakes now form wintering grounds for waterfowl. This is an area where there was little or no standing water in the past. —WALTER W. DALQUEST, *Midwestern University, Wichita Falls, Texas, November 15, 1955.*

The Incubation Period of the Clapper Rail.—In her review of incubation periods of North American birds, Nice (Condor, 56, 1954:182–183) pointed out the present inadequate knowledge of the incubation period of the Clapper Rail (*Rallus longirostris*). I have two observations on incubation period of this rail on San Pablo salt marsh, Richmond, Contra Costa County, California. In 1951 a clutch of 9 eggs was completed on April 17 and the last egg hatched on May 10; in 1953 a clutch of 8 eggs was completed on March 28 and the last egg hatched on April 20. In both clutches the incubation period was therefore 23 days. The period of hatching was somewhat less than 24 hours for both clutches. Thus, in view of the fact that hatching can take as long as 48 hours in Clapper Rails of the Atlantic coast (Nice, *op. cit.*:183), some records of 24-day incubation periods may well be expected.—Richard F. Johnston, *Museum of Vertebrate Zoology, Berkeley, California, December 12, 1955.*

Some New Bird Records from Brewster County, Texas.—Field work carried out in western Texas in the past several years has revealed the presence of four species which were not reported from Brewster County by Van Tyne and Sutton (Misc. Publ. Mus. Zool. Univ. Mich. No. 37, 1937) or subsequent workers. Specimens supporting these observations are deposited in the Texas Cooperative Wildlife Collection.

Parabuteo unicinctus. Harris Hawk. Lone individuals were seen by Wallmo 11 and 13 miles southeast of Marathon, on March 4, 1953, and May 1, 1953, respectively. Several observations of Harris Hawks were made by Wallmo in 1953 and 1954 northwest of Hovey in areas of Pecos and Jeff Davis counties immediately adjacent to the northern border of Brewster County. A male was taken by T. D. Moore 10 miles northwest of Hovey, Brewster County, in Pecos County, on October 11, 1954.

Eugenes fulgens. Rivoli Hummingbird. Dixon took one male in Boot Spring Canyon in the Chisos Mountains, at approximately 6800 feet elevation, on July 21, 1955, and a second male on July 26. Both were in a canyon bottom forest of Arizona cypress (*Cupressus arizonica*), bigtooth maple (*Acer grandidentatum*), and Graves oak (*Quercus gravesii*), which was also inhabited by the Blue-throated Hummingbird (*Lampornis clemenciae*). The Rivoli Hummingbird has not been recorded in Texas heretofore, although Miller (Condor, 57, 1955:165) reported its presence in the Sierra del Carmen of Coahuila, México, some 50 miles southeast of the Chisos Mountains.

Toxostoma rufum. Brown Thrasher. Wallmo took a male 12 miles south of Marathon on December 3, 1954.

Icterus galbula. Baltimore Oriole. On June 20, 1955, Dixon took a male in heavy brush surrounding a small pond 5 miles south of the Black Gap, in southeastern Brewster County, at 2800 feet elevation. This apparent first-year bird had a heavy deposit of subcutaneous fat and its left testis measured 5 × 8 mm.—Keith L. Dixon and O. C. Wallmo, *Department of Wildlife Management, Agricultural and Mechanical College of Texas, College Station, Texas, November 30, 1955.*

Palm Warbler at Point Reyes, California.—On October 9, 1955, Alan Craig and I observed a single Palm Warbler (*Dendroica palmarum*) in a chaparral area on Point Reyes about one-fourth mile from the lighthouse. It was studied in good light at a distance of about twenty-five feet for almost a minute. The habit of "wagging" its tail and its yellowish crissum and drab olive-brown appearance left no doubt as to the identity of the bird. The warbler seemed to be migrating south, along with many other small songbirds.

Previous to this record, there have been two specimens of the Palm Warbler collected in the state of California, one at Pacific Grove on October 9, 1896 (Emerson, Osprey, 2, 1898:92) and the other on February 2, 1953 (Johnston, Condor, 55, 1953:276) at Berkeley. There are also three published sight records of this species for the state (Monson, Condor, 46, 1944:22; Legg, Condor, 55, 1953:162; and The Western Tanager, 19, 1953:28, 42).—Charles D. Fisher, *Long Beach, California, November 29, 1955.*

NOTES AND NEWS

The illustration in color of the Olive Warbler appearing in this issue is presented through the generosity of Mr. Paul Grafe. Members of the Society are much indebted to him as also to the artist, Don Eckelberry, for his excellent painting.

Publication of the extensive paper by David W. Johnston on the reproductive cycle in the California Gull has been in part subsidized.

The local committee in charge of arrangements for the annual meeting of the Cooper Ornithological Society in June in Seattle has been designated by the Board of Directors as follows: *General Chairman,* Garrett Eddy; *Program Chairman,* Gordon Alcorn, *assisted by* Ian McT. Cowan; *Arrangements,* Fred Zwickel, *assisted by* William Goodge; *Finance,* William Rourke; *Entertainment,* Murray L. Johnson; *Publicity,* Burton T. Ostenson.

Newly elected officers of the Western Bird Banding Association are: Emerson A. Stoner, president; Howard L. Cogswell, Russell H. Pray, William K. Kirsher, and Lillian Henningsen, vice-presidents; Enid K. Austin, secretary; Francis H. Boynton, business manager; William K. Kirsher, editor.

COOPER SOCIETY MEETINGS

SOUTHERN DIVISION

NOVEMBER.—The monthly meeting of the Southern Division of the Cooper Ornithological Society was held on November 29, 1955, at the Los Angeles County Museum. The following names were proposed for membership: Brian R. Daly, 445 Magellan Ave., San Francisco, Calif., by Robert Orr; Mrs. Gordon B. Olsen, 3895 S. Clarkston St., Englewood, Colo., by J. R. Pemberton; Mrs. Florence M. Plann, 1996 Midlothian Dr., Altadena, Calif., by C. J. Parker; Carl W. Helms, Biological Laboratories, Harvard University, Cambridge 38, Mass., by C. V. Duff; John N. Hough, 1515 Mariposa, Boulder, Colo., and Glen A. Hutson, 725 Blossom St., Bakersfield, Calif., by Jack C. von Bloeker, Jr.; Lloyd P. Parratt, 402 Oakdale Dr., Claremont, Calif., and Evelyn M. Sharpless, Pala, Calif., by F. H. Boynton; Bayard H. Brattstrom, Dept. of Zoology, Univ. Calif., Los Angeles 24, Calif., and Mrs. Rosemary Quast, 1021–B Sixth St., Santa Monica, Calif., by Thos. R. Howell; Mr. Reginald Thomas Bloom, %Barclays Bank Ltd., Queensway Branch, Nairobi, Kenya Colony, East Africa, Mr. Cecil Ewart Cade, P.O. Box 568, Nairobi, Kenya Colony, East Africa, and Mr. Hugh F. I. Elliott, % The Secretariat, Dar es Salaam, Tanganyika Territory, East Africa, by John G. Williams.

Thomas R. Howell reviewed Painter's "Ornithogeography of the Yucatan Peninsula." Dorothy Groner reported having seen a Great Gray Owl in Yosemite on November 12.

Sidney B. Peyton showed his colored slides of "Nesting Birds of California, Utah, Colorado and Alaska."—DOROTHY E. GRONER, *Secretary.*

JANUARY.—The monthly meeting of the Southern Division of the Cooper Ornithological Society was held on January 31, 1956, at the Los Angeles County Museum. The following names were proposed for membership: Mr. Herbert Allen, 822 Wildrose Ave., Monrovia, Calif., by A. H. Miller; Donald H. Baepler, Dept. Zoology, Univ. Oklahoma, Norman, Okla., by Jack C. von Bloeker, Jr.; Bernard B. Butterworth, 1225 W. 39th Pl., Los Angeles 37, Calif., by F. H. Boynton; George A. Clark, Jr., 1 West Campus, Easton, Penn., by K. E. Stager; Richard Holmes, 305 N. Bradbury Dr., San Gabriel, Calif., by T. R. Howell; Clara M. Clapp, 3962 Dalton Ave., Los Angeles 62, Calif., Mrs. S. I. Hayakawa, 225 Eldridge, Mill Valley, Calif., Charles Walter Kossack, 715 Division St., Barrington, Ill., Rheinier Ivan Meyerholtz, 10781 N. Saratoga Rd., Cupertino, Calif., Philip W. Ogilvie, 9550 Faywood St., Bellflower, Calif., William Southern, 614 Prairie St., Clare, Mich., Mrs. William E. Taylor, 4667 Ironwood St., Saginaw, Mich., and David Raymond Williams, 6053 Vantage Ave., No. Hollywood, Calif., by C. V. Duff.

On behalf of the nominating committee, C. V. Duff proposed the following slate of officers for 1956: Jack C. von Bloeker, Jr., president; Thomas R. Howell, first vice-president; Robert L. Taylor, second vice-president; and Dorothy E. Groner, secretary. There being no further nominations, the slate of officers was duly elected. President von Bloeker appointed the following committee chairmen: Thomas R. Howell, program; Arnold Small, conservation; and Elton L. Morel, membership.

The program of the evening was given by

Alden H. Miller, who spoke on "The Natural History of the Nuttall Woodpecker."—DOROTHY E. GRONER, *Secretary*.

NORTHERN DIVISION

DECEMBER.—The meeting of the Northern Division of the Cooper Ornithological Society was held on December 1, 1955, at the University of California, Berkeley. New members proposed were Peter A. Jordan, South Fork Inn, North Fork, Calif., and James David Rising, 4406 Sunrise Dr., Kansas City, Mo., by F. A. Pitelka. President Reynolds announced that the nominating committee consisting of Junea Kelly, Eric Kinsey, and Robert Orr would make their report at the next meeting.

Loye Miller reviewed the book, "The House on Nauset Marsh" by Wyman Richardson, and A. L. Curl reviewed "Wild America" by R. T. Peterson and J. Fisher. The presence of Clark Nutcrackers at the coast near Carmel and generally at low elevations in central California was reported by Donald McLean.

The speaker of the evening was Mr. A. Mahler of the California Department of Fish and Game who gave an illustrated talk entitled "A Breakdown on Studies of Duck Populations and Breeding in Winter Areas."—ROBERT K. SELANDER, *Secretary*.

JANUARY.—The monthly meeting of the Northern Division of the Cooper Ornithological Society was held on January 5, 1956, at the University of California, Berkeley. Mr. Bartles Lance Benne, 317 N. Kensington, Kansas City 23, Mo., was proposed for membership by F. A. Pitelka, and Mr. Charles Hines, Jr., 810 Taraval St., San Francisco 16, Calif., was proposed by Howard Cogswell.

Alden Miller reviewed the recent A.O.U. research book, "Recent Advances in Avian Biology."

Junea Kelly presented the report of the nominating committee: Donald McLean, president; A. L. Curl, first vice-president; John Davis, second vice-president; and Mrs. Lillian Henningsen, secretary. The slate of the nominating committee was elected by unanimous vote. A motion of commendation and appreciation for the services of outgoing president, Eric Reynolds, was passed by acclaim.

Howard Cogswell reported on a trip to the Farallon Islands on December 31 and reminded the members of the proposed census of Robins on January 7. F. A. Pitelka commented on the influx of Clark Nutcrackers into the Monterey Peninsula and urged the reporting of observations of these birds to Laidlaw Williams or John Davis.

An excellent motion picture on the flight of Ruby-throated Hummingbirds taken by Crawford H. Greenewalt was shown by Junea Kelly. The speaker of the evening was Dr. J. Dan Webster of the California Academy of Sciences and Hanover College, Indiana, who spoke on "The Birds of Zacatecas, Mexico."—RALPH J. RAITT, *Secretary*.

FEBRUARY.—The meeting of the Northern Division of the Cooper Ornithological Society was held on February 2, 1956, at the University of California, Berkeley. New members proposed were: Life Member, Crawford H. Greenewalt, Wilmington, Del., by Junea W. Kelly; regular members, Mrs. Stanton L. Tainter, 2226 Berkeley, Salt Lake City, Utah, by Junea W. Kelly, and Dana R. Struthers, 1901 Jackson St., San Francisco, Calif., by A. Laurence Curl. President McLean announced the following committees for 1956: Natural Resources, A. Starker Leopold, chairman, Lowell Sumner, Wallace G. Macgregor, and Ian I. McMillan; Program, Alden H. Miller, Robert Orr, and all officers of the Northern Division, with president McLean, chairman; Publicity, Lillian K. Henningsen.

Mrs. Edith Nelson reported seeing two Emperor Geese on East Cliff Drive, Santa Cruz, on January 11, 1956. Mr. McLean noted that this species has been reported as far south as Morro Bay and also at Tomales and Humboldt bays and in the Tule Lake Area. King Eider Ducks were also reported on Tomales Bay this winter, and 118 American Scoters were seen on Drakes Bay by Allen Craig. Mrs. Nelson also reported a Scissor-tailed Flycatcher seen by her and Mr. and Mrs. Luther Dunlap on November 18, 1955, on West Cliff Drive, Santa Cruz.

The speaker of the evening was Mr. Fred Evenden, Director of the Junior Museum, Sacramento, who gave an illustrated talk on the Junior Museum Program.—LILLIAM K. HENNINGSEN, *Secretary*.

For Sale, Exchange, and Want Column—Each member of the Cooper Society is entitled to one short advertising notice in any issue of the Condor free. Notices of over 3 lines will be charged for at the rate of 25 cents per line. Send advertising copy to Jack C. von Bloeker, Jr., Los Angeles City College, 855 N. Vermont Ave., Los Angeles 29, California.

WANTED—The following serial issues to complete my personal library files; I will pay good prices: Audubon Magazine, vol. 2, 1889, no. 12; Atlantic Slope Naturalist, vol. 1, no. 1; Florida Naturalist, vol. 1, no. 1; Hawkeye Ornith. and Oologist, vol. 2, nos. 5–6; Indiana Audubon Bull., 1920, 1923 and 1925 issues; Journ. Maine Ornith. Society, vol. 2, nos. 2–4 incl., vol. 4, nos. 2–4 incl., vol. 5, no. 1; Murrelet, vol. 1, no. 2, vol. 4, no. 2; Oologist (Utica, N.Y.) vol. 1 compl.; Oregon Naturalist, 1894, vol. 1, nos. 1, 2 and 12; vol. 2, nos. 1–2; Sunny South Oologist, vol. 1, no. 3; W. W. Cooke, Distr. of Am. Egrets, Bur. Biol. Surv. Circ. no. 84, 1911.—FRED J. PIERCE, *Winthrop, Iowa.*

UNIQUE SERVICES FOR ORNITHOLOGISTS—Binocular repairs that often make glasses better than new, with cleaning and aligning done in 5 days—sooner in an emergency; new binoculars checked in our shop and guaranteed adjusted to U. S. Government specifications, with some models adapted by us especially for bird-watching; reprints of our Audubon Magazine articles: "Know Your Binoculars" and "How to Check Alignment," 10¢, no charge to C.O.S. members; personal replies to all individual questions. Write for details. If you have a binocular problem, let us help you solve it.—THE REICHERTS, *Mirakel Optical Co., Mount Vernon 15, N. Y.*

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FOR SALE—The "Tiny Tucker" Hummingbird Feeder, complete with instructions for use, $1.00, plus 15¢ postage; all profits used in maintenance of this wildlife sanctuary.—TUCKER BIRD SANCTUARY, *Box 53, Star Route, Modjeska Canyon, Orange, Calif.*

WANTED—Audubon Research Bull. No. 2, 1942, "The Roseate Spoonbill," by Robert Allen. Please quote price.—A. PETER MARGOSIAN, *253-A N.E. First Rd., Homestead, Fla.*

FOR SALE—My entire library (or single volumes) of rare ornithological and avicultural books. Send 3¢ stamp for list.—DR. LEON PATRICK, *1208 Virginia Way, La Jolla, Calif.*

FOR SALE—Small library of books on birds; will sell all or any part. Please write if interested. A. E. DAVIES, *P. O. Box 68, Stone Valley Rd., Alamo, Calif.*

FOR SALE—Shelford, Animal Communities in Temperate America, $8.00; De Serres, Migrations des Animaux, $16.00; Goldman, Biological Investigations in Mexico, $3.50; Whipple, Microscopy of Drinking Water, $7.50.—H. H. T. JACKSON, *Room 61, U. S. National Museum, Washington 25, D.C.*

PREPARATION OF MANUSCRIPTS FOR THE CONDOR

Articles published in the Condor normally are written by members of the Cooper Ornithological Society. Practically all the Society's money goes into the journal; no editor or business manager receives any pay other than the satisfaction of doing a service worthily. The preparation of good copy by the author will contribute greatly to accuracy of published output, dispatch in handling, and economy of production.

To be acceptable for inclusion in the Condor, articles must not duplicate in any substantial way material that is published elsewhere. Any type of subject bearing on birds may be considered; but the geographic areas of primary concern are western North America, Central America, and the Pacific Basin. Manuscripts may be sent to the editors at the Museum of Vertebrate Zoology. Proofs with edited manuscripts will be sent to authors, at which time reprints may be ordered.

In the interests of accuracy and economy, observe the following: do not duplicate data in text, tables, or charts; check citations to original sources and verify text references; quoted statements must be exact replicas of the original; preferably use vernacular names applicable to the entire avian species (for a guide in this regard, see "The Distribution of the Birds of California," Pac. Coast Avif. No. 27, 1944:5-34); in general, avoid subspecific vernaculars; insert scientific names for species but not the subspecific name except in taxonomic papers or where the race concerned has been critically determined by the author or his collaborators; revise the manuscript repeatedly to remove superfluous words and phrases, immaterial detail, and repetitious statements.

Note Condor style and usage. "General Articles" and the "Field and Study" items are set up in different form. Provide a concise, meaningful title, and, where needed, subtitles within the text. Footnotes are not used. The address line may serve to indicate institutional connection, and to it should be added the date of transmittal of the manuscript. Terminal bibliographies are desirable where five or more titles are to be cited; otherwise, the references may be included in the text. For bibliographic style, note closely the practices employed in recent volumes of the journal. A factual summary is recommended for longer papers.

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Illustrations.—Photographs should be glossy prints of good contrast. Make line drawings with India ink; plan linework and lettering for at least ½ reduction; do not use typewritten labels on the face of the drawing. Provide typed legends on separate sheets.

Helpful references on writing: Manual of Style, University of Chicago Press, and Rules of the Editorial Committee, University of California Press. On scientific nomenclature: A.O.U. Check-list (with supplements 19 through 30) and Pacific Coast Avifauna No. 27; authors are not required to follow either of these works.

THE EDITORS OF THE CONDOR.